

What's happening in water research this season?

By Dirk Richards, CSIRO Plant Industry and Australian Cotton CRC

Water remains an essential input into the cotton farming system and so research into the plants' response to water stress continues to be a focus of research in Australia. This article presents a brief overview of the irrigation and water related research being conducted throughout the Australia cotton industry this season. While not exhaustive, it includes trials being run on research stations and on-farm in collaboration with growers, consultants and other industry staff.



Cotton prior to skipping irrigation at flowering (a) Bollgard; and (b) Conventional.

WATER USE IN BOLLGARD II

Several trials have been established this season to investigate if Bollgard II differs from conventional varieties in its water requirements and optimum irrigation management strategies. Specific issues being considered include:

- The potential interaction between high fruit retention and rooting development, which may affect water use; and,
- In-season scheduling, moisture extraction and sensitivity to moisture stress.

Bollgard II moisture extraction patterns under plant stress

Bollgard II (BGII) cotton may have higher retention rates than conventional because it has not suffered tip damage and loses less fruit to *Helicoverpa* damage. If the plant puts more resources into developing these fruit, it could be at the expense of root development, which may in turn affect the capacity to extract moisture from the soil.

This research therefore specifically asks whether changes in fruit retention with Bollgard II affect root development. An experiment at Narrabri is manipulating boll load by manually removing fruit.

The subsequent effects on root development and moisture extraction are being monitored. Three treatments are being imposed through the season:

- No fruit removal (high retention);
- Partial removal (medium retention); and,
- Full removal (low retention).

These treatments are in combination with two water stress treatments — no stress and mild stress through skipped irrigations. Water extraction is being monitored with neutron probes both under the plant line and in the furrow. This information will help to understand if fruit retention affects root growth and if so, does this affect the irrigation management strategies of high retention Bollgard II crops.

For further information on this project contact Dr Grant Roberts (02 6799 1519) or James Neilsen (02 6799 1526), CSIRO Plant Industry, Narrabri.

Moisture stress and plant response

It is possible that the potentially higher early fruit load on BGII cotton makes it

more sensitive to water stress. This possibility is being tested to determine if BGII requires a different irrigation scheduling strategy to conventional crops.

Specifically, two experiments (Narrabri and Moree), are seeking to determine how sensitive Bollgard is to moisture stress at different plant development stages. In both BGII and conventional cotton there is a full irrigation treatment and a series of treatments where water stress is imposed at different times by skipping specific irrigations.

Key development stages are being targeted — specifically first flower, peak flowering and early-to-peak boll filling. Soil moisture, plant biomass and water applied are being monitored to quantify the plants' reaction and levels of stress. This experiment will tell if BGII differs from conventional cotton and at which stages of growth any differences are most important. This information can be used to develop better irrigation strategies for BGII.

For further information on this project contact Stephen Yeates (02 6799 1500) or Dirk Richards (02 6799 2416), CSIRO Plant Industry, Narrabri.

PLANT WATER RELATIONS OF COTTON

Most research on water use efficiency (WUE) has focussed at the farm or crop level. But the way in which individual plants use water is also important and may be affected strongly by soil type, environmental conditions (temperature, humidity) and variety.

For instance, the response of a plant to the available soil water status is modified by the rate at which the water stress is imposed. Therefore, to optimise the irrigation strategy for a given location it is necessary to know the response of the plant to soil type.

A series of experiments is investigating the effect of soil type on cotton plant water relations (PWR) across three different soil types in the area around Wee Waa. Having the experiments in relatively close proximity to each other ensures similar climatic conditions.

Plant water relations are being monitored through:

- Leaf area measurement;
- Plant water potential (pressure chamber); and,
- Measurement of stomatal opening.

In addition, soil water monitoring (with a neutron probe), and plant yield measurements are being conducted. Moisture stress treatments are being imposed to half the plants at flowering to provide a range of stress conditions for PWR monitoring. These experiments will help us understand how soil type affects the way in which plants use water and may be used to refine irrigation strategies.

For further information on this project contact James Neilsen (02 6799 1526), CSIRO Plant Industry, Narrabri.

WATER USE AND FARMING SYSTEMS

Cotton-vetch rotation cropping and water use efficiency

Vetch grown as a green manure cover crop during winter has shown great potential to fix nitrogen and increase soil organic matter. But the vetch crop is using water, and there is a need to understand if the benefits from vetch outweigh the costs in terms of water use (for example, the water could be used for something else).

Research is underway to quantify water use under the cotton-vetch system to complement existing research findings. At present, soil moisture is being monitored in continuous cotton and cotton-vetch rotation treatments at Narrabri, with classification of soil moisture attributes under the two systems. This research will enable growers to make more informed decisions about the use of vetch and its benefits and costs.

For further information on this project contact Dirk Richards (02 6799 2416) or Dr Ian Rochester (02 6799 1520), CSIRO Plant Industry, Narrabri.

HydroLOGIC demonstration trials

Research results from previous trials have demonstrated that the HydroLOGIC software can be used to effectively schedule in-season irrigations in limited water situations. This management tool has the potential to assist cotton growers maintain productivity in limited water situations and to maximise the use of effective rainfall and the available water allocation.

To evaluate and promote the current software, several comparison trials have been established in 2004–05. These consist of a single field split into two irrigation



Single skip irrigated cotton.

management units, allowing a direct comparison between the existing growers' irrigation management and field management using HydroLOGIC.

Decisions in scheduling are documented in a 'Decision Diary', and all other management recorded and incorporated into the HydroLOGIC predictions (where possible). These experiments will help document the benefits that HydroLOGIC offers as well as validating the system.

For further information on this project contact Dirk Richards (02 6799 2416), CSIRO Plant Industry, Narrabri.

Row configurations

Throughout the cotton industry there is increasing interest in the use of different row configurations to achieve earlier crop maturity and/or higher yield. But there is little information on the WUE of cotton in these different configurations.

A comparison of the response of Bollgard II and conventional cotton to varying irrigation regimes under various row configurations is being carried out by Dr Phil Goyne on the Darling Downs. Answers are sought on the results of applying one or two irrigations to skip-row plantings and on the long term economics of using skip-row systems compared to solid configurations.

The trials are being conducted to understand the interaction of row configuration, crop agronomy and soil water extraction. The data may then be extended and various management scenarios assessed using an enhanced version of the OZCOT crop model.

For further information on this project contact Dr Phil Goyne (07 4660 3636), QDPI&F, Hermitage research Station.

EVAPORATION CONTROL

Technologies for controlling evaporation from storages

Research has shown that considerable water is being lost from the farm system through evaporation and drainage from storages and distribution channels. Experiments initiated by the National Centre for Engineering in Agriculture (NCEA) and funded by Queensland Natural Resources and Mines through their RWUE program, are assessing different techniques and technologies for controlling evaporation from storages.

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Evaporation management trial sites: Netpro shade structure (a); and E-VapCap cover (b).

These experiments are located at St George, Stanthorpe, Capella and Dirranbandi. Two structural control methods are being tested — E-VapCap (at St George) and Netpro shade structure (at Stanthorpe). A chemical control technique, WaterSaver, is also being tested at Capella and Dirranbandi.

Evaporation rate is being measured using high precision pressure sensor transducers, which accurately measure changes in water depth. These experiments will quantify the effectiveness of these options at reducing evaporation and enable effective analysis of cost/benefit.

For further information on this project contact Erik Schmidt (07 4631 1347), NCEA, Toowoomba, David Schmiede, Qld NRM, Brisbane, or Sarah Hood, Sustainable Irrigation Systems, St George.

WATER USE EFFICIENCY

Industry wide survey of farm water use efficiency

In 1998 Dr Sunil Tennakoon (CSIRO) assessed the whole farm WUE and application efficiency (or field efficiency) of 25 cotton farms across six different valleys. This project is being re-visited by Mitchell Carter (NSW DPI) and Dirk Richards (CSIRO) to establish if any improvements in WUE efficiency have occurred.

New water use data will be collected from the original 25 farms for comparison with the previous water use data. A survey about irrigation practices and changes made will help to pinpoint what has been the main influence relating to increasing or decreasing WUE.



Information is being collected at the field (a); and whole farm level (b)

For further information on this project contact Mitchell Carter (02 6799 1537), NSW DPI, Narrabri.

DEEP DRAINAGE UNDER IRRIGATED COTTON

Queensland

There is increasing awareness of the potential for deep drainage (DD) in many of the heavy textured soils (vertosols) that are flood irrigated. Research is currently being conducted by Qld NR&M to determine more precisely the amount of deep drainage for various locations and soil types.

This research is using drainage lysimeters installed in seven different soils covering the range of soil types used for cotton irrigation in Queensland. The 21 lysimeters (seven sites x three lysimeters/cotton field) have been installed from Dalby to Dirranbandi.

In each field a lysimeter has been installed at the head ditch, middle and tail drain of each furrow run (which range from 800 to 1000 metre length). The infiltration opportunity time from irrigation is estimated from furrow flow rate and infiltration advance times using the SIRMOD furrow irrigation model.

This research will provide an estimate of rates of deep drainage, which will provide a better understanding of the irrigation strategies required to reduce losses to deep drainage but also ensure sufficient leaching of soil to prevent salt buildup.

For further information on this project contact Dr Des McGarry, Qld NR&M, Indooroopilly.

New South Wales

Drainage is the most difficult component of the water balance to measure and a new facility being constructed at Narrabri aims to shed light on its magnitude under irrigated cotton in the northern Murray-Darling basin. The variable tension drainage lysimeter is being installed under a wheat-cotton rotation crop at Narrabri, and will be used to directly measure deep drainage at two metres below the surface as well as to monitor water quality.

Deep drainage responses will be correlated to management practices and climatic events, and compared to estimates made by alternative cheaper methods such as barrel lysimeters, chloride mass balance and resistivity. The facility is part of a network of regional drainage experiments, and the results will be cross-referenced to those from satellite sites and elsewhere within the project site.

The experimental data will also be used to verify the performance of crop and

water balance models, which are then used to extrapolate water balance performance for different cropping systems over space and time.

For further information on this project contact Dr Anthony Ringrose-Voase (02 6246 5956), CSIRO Land and Water, Canberra or Tony Nadelko (02 6799 2452), CSIRO Land and Water, Narrabri.

OVERHEAD IRRIGATION SYSTEM EVALUATION

Lateral move (LM) irrigation scheduling

Alternative irrigation systems for cotton such as lateral moves are now being investigated by a number of growers as they strive to improve water use efficiency. Because these systems are expensive to install it is critical to obtain the highest yield and best WUE possible, to recoup the costs.

Mitchell Carter, NSW DPI, is conducting a trial at Wee Waa this season investigating scheduling irrigations for a lateral move system using capacitance soil moisture probes. Most of the soil moisture measurement instruments available on the market do not accurately measure soil moisture in the top 10 cm of the profile.

This creates a problem when scheduling irrigations for cotton being irrigated with lateral move systems — which produce crops with potentially shallow root systems. This research will help growers achieve the full benefits from lateral move systems by providing guidelines for more accurate irrigation scheduling.

For further information regarding this trial contact Mitchell Carter (02 6799 1537) NSW DPI, Narrabri.

Improving the profitability and sustainability of centre pivot and lateral move (CP&LM) irrigation within the Australian cotton industry

This newly funded project will focus on investigating surface water movement, soil water infiltration, deep drainage and water



Centre pivot overhead systems under investigation.

use efficiency for different CP&LM water application technologies. The application devices under investigation will include various sprinkler and LEPA configurations over a range of soil types, soil deficits, application depths and diking options.

Field trials will be conducted under commercial CP&LMs with collaborating growers at six sites. Through visual tools developed by the project, growers and consultants will be able to understand soil water movement under CP&LM machines. This project aims to increase awareness of management issues



PRD glasshouse trial.

for CP&LM machines through development of decision support systems to demonstrate different management scenarios and the effect management decisions can have on machine performance, rainfall capture and water use efficiency.

For further information regarding this trial contact David Wiggington or Joe Foley (07 4631 1559), NCEA, Toowoomba.

Cotton's response to Partial Rootzone Drying (PRD)

PRD, as the name suggests, is a novel irrigation strategy where the application of irrigation water is applied to only a portion of the total crop rooting zone, creating a 'wet' and 'drying' region within the rootzone. Reduced rates of crop water usage are possible from a reduction in transpiration area and rate — primarily through an increase in root abscisic acid.

Glasshouse trials conducted by Simon White, NCEA, are investigating if PRD could cause a biochemical (elevation in abscisic acid), and physiological response in cotton. Abscisic acid levels are measured directly from cotton stem sap samples as well as leaf stomatal conductance and soil moisture.

With this information it is hoped to determine whether cotton does respond to

PRD and implement a second glasshouse trial where a range of PRD treatments would be applied to maximise PRD response. Ultimately, guidelines will be produced on the level of soil moisture drying required on the 'dry' side for it to be successfully implemented in the field.

For further information regarding this trial contact Simon White (07 4631 1871), NCEA Toowoomba.

Research results and outcomes from these trials will ultimately be added to the Australian Cotton CRC's WATERpak publication, which forms the reference document for the industry's newly released Best Management Practice Land and Water Management module. For further information regarding WATERpak and BMP please visit the Cotton CRC and Cotton Australia web sites.

If you would like to find out more about a trial, contact numbers can be found on the Australian Cotton CRC web site under the Cotton CRC staff list (www.cotton.crc.org.au/StaffList/stafflist.htm).

Funding for many of the research trials listed has been provided by the Cotton Research and Development Corporation. For further details please visit www.crdc.com.au/

*On behalf of the Cotton Industry Extension Water Focus Team.