The Association of Australian Cotton Scientists inaugural Australian Cotton Research Conference

8th - 11th September 2013

Promoting inquiry, networking and collaboration in the Australian cotton research community

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NSW GOVERNMENT Department of Primary Industries

Australian Cotton Research Conference

8th - 11th September 2013

The Crossing Theatre, Narrabri, NSW, Australia

Hosted by

The Association of Australian Cotton Scientists

Welcome to delegates

Dear Delegates,

On behalf of the organizing committee I would like to welcome you to Narrabri, and to the 2013 Australian Cotton Research Conference, hosted by the Association of Australian Cotton Scientists. We have nearly 90 high caliber talks including 3 plenary presentations for you to enjoy, and about 170 participants with which to bounce around ideas.

Each of the three days of presentations has a theme: **Monday** is Breeding and Post Harvest; **Tuesday** is Agronomy, and **Wednesday** is Pest Management. There will be two concurrent sessions on each day. The aim of this approach is to help delegates gain an overall perspective of each area of cotton research and solidify that understanding. It is to this end that each day will finish with a session called the **"Devil's advocate with a glass of wine"** which will involve two "Devils", an adjudicator, wine, and you. The devils have been commissioned from our healthy pool of argumentative researchers and at least one devil will attend most talks of the day. For more information on these sessions, see Page 12.

As part of the entertainment, Harmony Inc., a community based group, will present a small section of contemporary choral music at the Welcoming Ceremony at the Crossing Theatre; Helen Conroy will present her own expression of folk-rock at the Eulah Creek Campfire dinner; and the bush band November Shorn will get everyone's foot tapping at the Conference dinner at Craigdon Guest House.

The aim of this conference is that people leave the conference feeling that they have been well looked after and refreshed. The ultimate aim is for each delegate to feel a sense of enthusiasm and vibrancy around their work.

Acknowledgments: This conference has been a team effort and I would like to thank everyone involved. In particular I am very grateful to the conference committee for all their hard work and dedication. For example, I am very thankful to David Larsen for managing and putting together the website; Lewis Wilson, Nilantha Hulugalle and Jeff Werth for reviewing the abstracts; Lewis Wilson and David Larsen for getting the program together; Robert Mensah, Steve Allen, Junji Miyazaki and Warren Conaty for undertaking numerous jobs to ensure the conference ran smoothly; Phil Armytage for liaising with CSD; and especially Yvette Cunningham for enthusiastically organizing the conference logistics. Other people not on the committee who have contributed greatly include Simone and Viliami Heimoana for running the Eulah Creek Excursion; Jody Draheim for doing the paper work associated with the conference, Jo Cain for her sage financial advice; Michael Bange and the AACS committee for their support; and Greg Constable for his counseling. I am very grateful to our sponsors, CSIRO Plant Industry, CSD, and particularly our major sponsor, the CRDC for their generous support. Without their contribution many events would not have been possible.

Best wishes,

Mary Whitehouse

(Conference Committee Chair)

Other Committee members:

Yvette Cunningham	David Larsen	Jeff Werth
Lewis Wilson	Warren Conaty	Juni Miyazaki
Steve Allen	Nilantha Hulugalle	Phil Armytage
Robert Mensah		

Welcome on behalf of the Association of Australian Cotton Scientists

Dear Delegates,

Welcome all to Narrabri the birthplace of the modern cotton industry and cotton research community. On behalf of the Association of Australian Cotton Scientists I'd like to welcome you all to our inaugural Cotton Research Conference. With the cessation of the Cotton CRC and it's Science Forum and the evolution of the Australian Cotton Conference toward broader industry issues, there was a recognised need for a gathering of scientists that would be focused on the specifics of cotton science, and which would allow all those involved in cotton research to have a forum to present their research to others. This was a great opportunity for the newly formed Association of Australian Cotton Scientists to deliver a conference which would help meet one of its key objectives of 'facilitating communication between scientists and encouraging collaboration and integration across agencies and disciplines'. I am personally excited about the breadth and quality of research being presented and look forward to catching up with new and old acquaintances.

While at the conference I would ask those who are not already members of the association to consider membership. As a united association we can begin to have a voice supporting a dynamic cotton industry that highly values our research, and its researchers. To that end in the past year we have already gained traction towards representation on key industry committees and activities, with active encouragement from CRDC and Cotton Australia. Please also consider attending our Annual General meeting after lunch on Wednesday during the conference, or come and speak to me or one of committee members on any ideas you may have for the association.

Finally, I would like to thank all the delegates for your attendance; your strong support has ensured the conference will continue to exist well into the future on the cotton calendar. Also thank you to our generous conference sponsors CRDC, CSIRO, NSW DPI, and CSD. Lastly for the efforts of Mary Whitehouse our conference chair and the conference committee for making the vision a reality, and helping cotton research across all disciplines come to light. It has been a great pleasure to witness the keen enthusiasm and collegiate effort that ensures that the ideals of the association will be realised. Enjoy the conference.

Best Regards,

Michael Bange

Michael Bange

Contents

General Information

Conference location

The conference will be held at the Crossing Theatre Narrabri.

The venue is located on the Newell Highway on the eastern bank of the Namoi river. Narrabri is a prosperous, modern country town servicing a large and highly productive agricultural district.

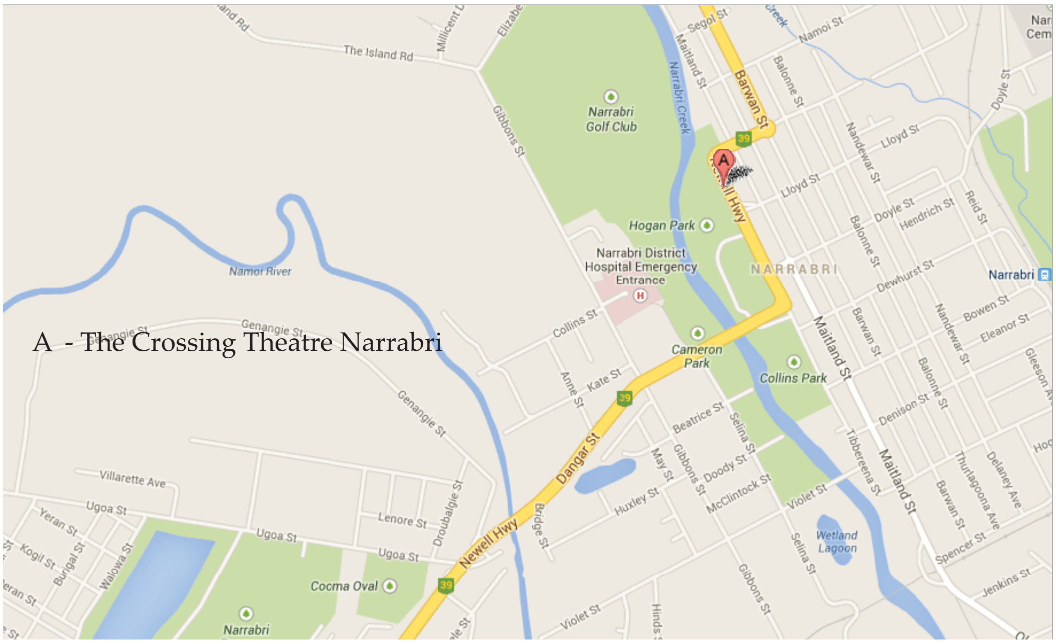
The Narrabri Shire covers 13,000 km^2, and is in the heart of the rich Namoi Valley in north western NSW. Narrabri is a strong service and transport centre for the wheat, cotton, and livestock industries of the district and is easily located six hours from both Sydney and Brisbane, where the Newell and Kamilaroi Highways meet. Coal and gas industries are also well established and expanding as new resources are discovered.

Narrabri is the headquarters for two major agricultural research stations, the Australian Cotton Research Institute and the IA Watson Grains Research Centre.

The Narrabri district has become an increasingly popular tourist centre because of its proximity to Mount Kaputar National Park, the Pilliga Forest, the CSIRO Australia Telescope, and other rural attractions of the district. Tourism plays a significant role in Narrabri's economy, with an average of 30,000 tourists annually.

For more information about Narrabri and its surrounds visit: www.narrabri.nsw.gov.au. See street map below and in tourist information booklet in your satchel.

Narrabri Town Map including The Crossing Theatre



Transportation and Parking

Most motels are within walking distance of the Crossing Theatre. Thommo's and the Albany are a bit further about 2 km.

Buses:

There are no regular buses.

Those who have requested pick up will be met at the airport or motels.

Special bus services for events will depart from the Crossing Theatre.

Taxis:

Narrabri Radio Cabs (02) 6792 2552

Parking:

There is ample free parking at the Crossing Theatre. Enter the parking area to the left of the Cotton Information Centre.

Registration information

The registration desk will be located in the foyer of the main auditorium of the Crossing Theatre.

Registration desk opening times

If chasing conference help look for people with bright coloured conference label. They will be able to point you in the right direction.

Sunday 8th Sept 7-9pm

Monday 9th Sept 8.30 - 10.30 am

Tuesday 10th September 8.45 -9.30 am

Wednesday 11th September 8.30 - 9.00am

Registration fees

Conference registration - FULL	$340
Conference registration STUDENT	$200
Conference registration - full discount (early bird)	$290
Conference registration - student discount (early bird)	$150
Conference registration - other (eg accompanying spouse)	$120
Conference registration - one day flat rate	$180

All delegates will receive an identification name badge with pre-bought tickets upon registration.

Please return the name badge at the end of the conference for recycling.

Information for Presenters

Posters

All posters will be displayed for the entire duration of the conference in the Riverside Room of the Crossing Theatre. Upon arrival proceed to the registration desk to receive instructions of where posters are to be placed. The timing of poster session is in the program.

Oral Presentations

If you have not already downloaded your presentation via the web site please bring your presentation on a USB Memory stick or CD/DVD ROM.

The presentations should be loaded on the day before your session in order for us to link to session masters. This will enable us to smoothly run the presentations as well as allowing you to check for last minute problems. - see the registration desk for details

Presentations will not be accepted directly proceeding the session.

There will be a volunteer in the auditorium to assist your presentation upload to the display computer. Please familiarise yourself with the display controls at this time. In order to stick to our tight schedule each speaker is given 12 minutes talking time plus 2 minutes for questions and answers and 1 minute change over and introduction (i.e 15 minutes maximum). Plenary speakers will have 1 hour.

Awards

Awards presented at the conference dinner including

Best student talk

Best student poster

Computers and Internet Access:

Public internet access is available through the Narrabri Town Library during business hours and the town is well served by Telstra 3G mobile broad band network. Wi Fi access is available at MacDonalds, which is 2 minutes walk from the Crossing Theatre.

Conference Merchandise:

You will be able to pick up your pre-ordered T shirts at the registration desk when you pick up your conference satchel. Additional conference T shirts and hats can be ordered from the registration Desk, but must be paid for by credit card.

Social Events

1. Sunday night 8th September, 7-9pm - Welcoming Reception at the Crossing Theatre

Come along to this free night and a great chance to catch up with old friends and relax. Registration will be open so you can pick up your conference pack and program. There will be finger foods (plenty so you probably won't need dinner as well!) and a drinks tab - so first-in-bes- quenched! The bar will also be open so you can purchase extra refreshments at very reasonable prices. Not to be missed, the local choir 'Harmony Inc' will sing several songs – these guys are fantastic! The Chair of the Conference Organising Committee, Dr Mary Whitehouse and inaugural Chair of the Association of Australian Cotton Scientists, Dr Michael Bange will welcome you all to Narrabri and the conference.

Dress: Casual

2. Monday Night, 9th September – no planned events

So you can rest, socialise, prepare, discuss, review, party or cruz da web as you see fit! Please sample the delights of Narrabri Cuisine – see the next page for a range of options!

Dress: If you want to....

3. Tuesday evening 10th September – Eulah Creek Campfire Dinner

This is **free** but we have only catered for those of you that replied indicating that you would like to attend the excursion.

Buses will be leaving the conference venue (Crossing Theatre) to travel to Eulah Creek Hall at **4:57pm sharp**, returning to town from 9 to 10pm.

The evening will be a night under the stars with a camp-oven theme! There will be lots of time to discuss cotton research and socialize with friends and colleagues as well as enjoy live music performed by Helen Conroy, drinks (wine, cold beer and softer options, as well as real coffee and tea) and great food - a whole lamb and pig spit roast cooked over an open fire and lots of veggies cooked Hāngi style.

Just bring yourself and maybe a jumper or jacket as the evenings cool down quickly.

This event will be supporting the Narrabri High School Year 10 class who are catering this event. The students are raising money for a humanitarian trip to Cambodia to build much needed houses. The students will be working under the watchful eye of Simone and Viliami Heimoana, who have made many a Hāngi to feed hungry Tongan masses.

4. Wednesday evening/night, 11th September - Conference Dinner

Buses depart from the Crossing Theatre at 6.15 pm sharp.

This will be a night of fun with great food, awards (both serious and comical!) and live entertainment from renowned bush band 'November Shorn'. Buses will take you out to Craigdon, which is a guest house and function centre well known for its location and beautiful old buildings (www.craigdon.com.au/). Returning buses will be staggered with the first leaving at 11pm. There will be a tab and wine on tables but bring some cash for extra drinks if you want to party.

Dress: Smart casual

5. Thursday 12 September - Possible morning Visit to ACRI

If there is enough interest we will arrange a trip to ACRI in the morning to show people the facilities.

AGM

The inaugural meeting of the Association of Cotton Scientists will be held at lunch on Wednesday in the mail auditorium - See the flier in your conference pack.

Visitor Information

Eating out in Narrabri

Cafes:		
One 23	Ph: (02) 6792 2728	123 Maitland Street
T Table	Ph: (02) 6792 1860	Maitland St (main street)
Crossing Theatre	Ph: (02) 6792 5654	Tibbereena St (Newell Hwy)
The Cafe	Ph: (02) 6792 1900	Maitland St (main street)
Watsons Kitchen	Ph: (02) 6792 1366	151 Maitland St (main street
Restaurants		
RSL Outback Shack	Ph: (02) 6792 1202	7 Maitland Street
The Nandewar Motor Inn	Ph: (02) 6792 1155	Newell Highway
Allegra Restaurant Adelong Motel Ph: 02 6792 1488	174 Maitland Street	
Thurlow's Restaurant	Ph: (02) 6792 2312	142 Maitland Street
On-Lee Chinese Restaurant	Ph; 02 6792 4488	64/266 Maitland St
Chans Chinese Restaurant	Ph: 02 6792 2654	98 Maitland Street
Rumours Narrabri Golf Club	Ph: (02) 6792 2344	Gibbons St
Namoi Hotel	Ph: (02) 6792 2147	Maitland St (main street)
Tattersall Hotel Bistro	Ph: (02) 6792 6555	Maitland St (main street)
Crossroads	Ph: (02) 6792 5592	Maitland St (main street
Gourmet Goblet Narrabri Bowling Club	Ph: (02) 6792 2566	Maitland St (main street)
Thai Home		Cooma Rd (Newell Hwy)
Takeaways		
Eagle Boys Pizza	Ph: (02) 6792 4644	Tibbereena St (Newell Hwy)
The Pizza Joint	Ph: (02) 6792 2900 Tib-bereena St (Newell Hwy)	
Fiesta Chicken	(02) 6792 2311	Tibbereena St (Newell Hwy)
KFC		Maitland St (main street)
MacDonalds		Maitland St (main street)
Subway		Maitland St (main street)
Amenities		
Banks and ATMS		
Crossing Theatre Cashcard ATM Tiberrena St (Newell Hwy)		
ANZ	Maitland St (main street)	
WestPac Maitland St (main street)		
Commonwealth Maitland St (main street) NAB	Maitland St (main street)	
Emergency / Police / Ambulance / Fire	In an emergency dial 000 and state the service you require.	

Notes for session chairs:

Thank you for agreeing to help run the conference we appreciate it

Your assistance is vital in ensuring everything runs smoothly

Please read the suggestions below

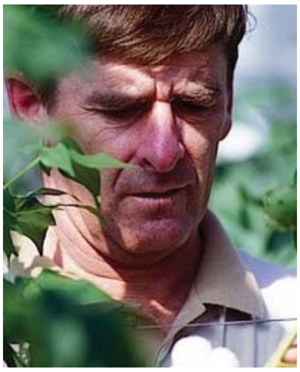
- Please ensure that all presenters have their talk loaded the day before. This will greatly enhance sessions running on time. (NB presentations need to be linked to master documents before the session.)
- Please familiarize yourself with the A/V equipment and also the AV assistant associated with the room your session is in (Dave Larsen, Darin Hodgson and Nicole Bell).
- Please introduce yourself to the presenters in your session ahead of time and ask each presenter for one or two sentences of introduction for you to use at the start of their talk
- Please ensure that the presenters know the time limits for their talks , 1 hour for plenary talks (45 minutes and 15 Minute question time) , 15 minutes for all others (12 minutes talk, 2 minutes questions and 1 minute changeover)
- Please ensure presenters know how to use equipment and stick to time STRICTLY.
- ***Do not allow presenters to run over time***
- We want attendees to be able to move between sessions so it is vital that the session are kept to time. Warn speakers at 10 minutes that they have 5 minutes remaining, Get up and stand next to them when time is up, if necessary move in, thank them and introduce the next speaker. (Plenarys are different)
- Above all enjoy yourself, inject a bit of humour where you can and encourage a few questions - Its a good idea to think of one as a back-up that you can ask if necessary - there is nothing worse than no reaction at all!

Program for ACRC 2013 Narrabri Conference

"Devils Advocate and a glass of wine" session

The concept of a Devil's advocate session was originally developed in 2010 for an Animal Behaviour conference where it successfully encouraged delegates as a group to discuss freely points of interest. Devil's advocate sessions start with some wine. Next, the Devils will take it in turns to express an opinion (possibly counter to their own) on an idea or theory from the day that is controversial or of interest. They will then invite everyone else to counter their perspective. This will allow delegates to highlight or challenge some of the ideas and theories generated from talks during that day. The session will be managed by an adjudicator who will make sure that no delegate (or devil) talks for too long or too often, and that everybody "plays the ball not the player". At the end of the session the adjudicator will summarise the day's events.

Plenary Speakers



Dr Greg Constable

Cotton breeding

Dr Greg Constable completed his BAgSc in 1970 and his MSc in 1975, both through Sydney University and completed his PhD in 1982 through ANU. Greg joined the NSW Department of Agriculture in 1972 and his initial career focussed on agronomy and physiology of cotton and grain legumes. His PhD on carbon fixation and distribution in cotton led to some of the seminal publications in this area. Greg's international reputation in crop agronomy and physiology, strong background in genetics was recognised by CSIRO and in 1991 he was poached to lead their cotton breeding team. Within the team Greg has specialised in breeding cotton for full season cropping systems and has also initiated breeding for improved fibre quality. He has also played a key role in fostering linkages between molecular biology and breeding and in the implementation of GM cotton, which has had tremendous benefits to the industry.

Greg has been an active industry citizen, developing the bid for the first Cooperative Research Centre (CRC) for Sustainable Cotton Production and as its Director from 1993 to 1998. Greg is currently a CSIRO Fellow with the Cotton Management and Improvement Program at Narrabri. He was formerly CSIRO Program Leader (1998-2009), Stream Leader (2006-2012) and Group Leader (1994-2012). Greg continues to mentor younger scientist in crop physiology, agronomy and breeding. His strategic thinking, no-nonsense style and willingness to give an honest opinion are widely appreciated. In 2003 the influential Australian business magazine The Bulletin, judged Dr Constable 'Australia's smartest scientist'. Greg has twice won the Australian Cotton Researcher of the Year, and the CSIRO Chairman's medal (team) and has received many other prestigious awards.

Abstract:

Cotton breeding: past and future; conventional and molecular; and important interactions

With the modern Australian cotton industry expanding in the Namoi Valley through the 1960s, CSIRO Plant Industry decided to combine all its cotton research personnel from Kununurra and Griffith into one unit at Narrabri in 1972. This Cotton Research Unit had a foundation of three experienced scientists in cotton plant breeding, agronomy and entomology to provide leadership in science and strategic planning. At that time the plant breeding group comprised one breeder and one technician. In 2013, 41 years later, the same group has three plant breeders, three post doctoral fellows and 16 permanent technicians with high adoption of elite conventional and transgenic cultivars covering 3m ha in Australia, north and south America and Europe. What factors contributed to that success and what is required for the group to continue and even increase progress? This paper considers those questions in broad detail; other papers in this conference will present concise aspects of some cotton breeding issues. Other than hard work, the factors for success include good people, practices and structure combined with corporate support and encouragement. A long term commitment by scientists and technical staff is required as well as a clear strategy and objectives with flexibility and regular revision. Future challenges for industry include water supply, diseases and pests as well as ways to maintain yield and quality increases. It is concluded that cotton breeding will continue to evolve â€" some aspects of the research will be easier with more use of molecular tools as an integrated component of the process; other aspects will continue to be old fashioned. Continual integration with other research disciplines will be required.

Dr David C. McKenzie

Soil health and management

David is a Soil Science Consultant based in Orange. He has Bachelor of Natural Resources and Master of Science in Agriculture degrees from University of New England and a PhD in soil physics from University of Sydney. He has 35 years experience in soil assessment and management. Most of David's work has been for agricultural clients but recently he has become involved with 'agricultural resource assessments' for mining companies in NSW and soil-related legal work.

He was a soil scientist with NSW Agriculture for fifteen years; at Trangie 1981-88, then in Sydney until 1996. During this time he had a close association with Universities of New England and Sydney and supervised the projects of several students. David was co-founder of the SOILpak concept and provided decision support systems and training courses for cotton farmers and their advisers. He received the award 'Cotton Researcher of the Year 1987' from ACGRA.

David established 'McKenzie Soil Management' in 1996. Soil survey work for new vineyards was the main activity initially. More recently, contracts have included soil surveys for sandalwood plantations across northern Australia, a soil carbon review for the dairy industry, and soil assessments for mining companies that improve mine closure outcomes for agriculture.

http://www.soilmgt.com.au/

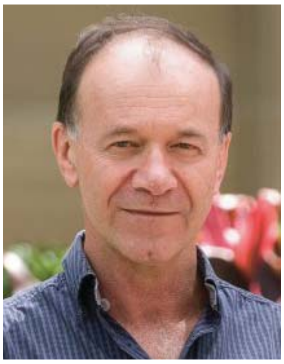
Abstract:

Soil appraisal and management in the cotton industry – achievements so far and future opportunities

Soil science is finally receiving the attention it deserves at the national level. An ambitious Soil Research, Development and Extension Strategy is being developed under the National Primary Industries RD&E Framework. Progress is being facilitated by the Advocate for Soil Health, Major General Michael Jeffery.

The Australian cotton industry is well placed to make the most of opportunities associated with these initiatives. A strong foundation already exists. Soil-related RD&E programs over the last thirty five years have delivered major benefits for cotton farmers and their associates. Productivity has been boosted by a broad range of outputs including controlled traffic farming methods, precision agriculture technologies, crop rotation strategies, nutrient management refinements, and measures to control waterlogging, sodicity and salinity. The SOILpak decision support system – together with NUTRIpak and WATERpak – was developed to capture all soil related information in a user-friendly format.

Further RD&E work is required urgently. For example, cotton industry soil information in NSW has been underutilised in the recent development of Strategic Regional Land Use Plan maps, and associated procedures for assessment of Biophysical Strategic Agricultural Land. Consequently, cotton growers often are not well placed in land management negotiations with mining and gas companies. The development of a web-based LANDpak manual by the cotton industry would be advantageous. The existing 'paks' – particularly SOILpak – require inclusion of the results from RD&E programs over the last 15 years, plus recent case study descriptions. The extension network for distribution of soil information to cotton farmers also needs to be revitalised.



Prof Myron Zalucki

Insect ecology and behaviour, including Helicoverpa species

Myron (pronounced Meron) is an insect ecologist with a strong track record in both applied and basic research. He completed his BSc(hons) at ANU in 1976, his Ph.D. in 1982, at Griffith University and joined the former Entomology Department at UQ in 1981. He became Professor in 2001. Myron's PhD studies focussed on insect/plant interactions, particularly Monarch butterflies and milkweeds as a model study system. This is a passion that he has pursued throughout his career and he has used various model systems to ask questions ranging from the interaction of host chemistry and induced plant defences on oviposition behaviour and early stage caterpillar survival, to the effects of learning on oviposition behaviour at a landscape level and of climate on insect abundance and distribution.

A substantial amount of Myron's applied research has been on the ecology and biology of Helicoverpa spp, the major pests of Australian field crops. Myron was a core member of the Helicoverpa Inland Research Group that pioneered research to unravel the ecology of the Helicoverpa complex in Australia and implications for management. Never shy, Myron is well known for challenging current dogma and sifting facts from assumptions. He was awarded the Ian MacKerras Medal in 1996 for excellence in Entomology by the Australia Entomological Society. He chaired the organising committee for the XXII International Congress of Entomology held in Brisbane in August 2004. He has worked with colleagues on various entomological problems and questions in China, North Korea, India, Oman, the South Pacific and North America.

http://www.biology.uq.edu.au/staff/myron-zalucki

Abstract:

Thirty odd years of research on Helicoverpa biology and ecology; what have we gained?

I reflect on over 30 years of research on the biology and ecology of Helicoverpa species in Australia. I concentrate on three areas:
(1) population dynamics at a landscape level,
(2) host selection or oviposition behaviour and
(3) neonate feeding behaviour.

The research has taken place within the context of a rapidly changing management environment: from sample, spray and pray IPM to widespread adoption of GM cotton. The questions we would like to answer are: has Helicoverpa spp. abundance and/ or behaviour changed as a consequence of the changing agricultural landscape? The problem is that we have not addressed the fundamentals underpinning the behaviour and ecology of these pest heliothines to be confident in any answer.

Program Overview

Sunday	Monday Breeding & P. Harvest	Tuesday: Agronomy	Wednesday: Pest Management	Thursday
8th Sept	9th Sept	10th Sept	11th Sept	12th Sept
	8:30 Coffee/tea	8:45 Coffee/tea	8:15 Coffee/tea	
	8:40-8:55 **Welcome to Country**			
	8:55-9:00 Housekeeping 9:00-9:15 **AACS Welcome -Mick Bange**	9:00-9:15 Housekeeping	8:30-8:45 Housekeeping	
Planes from Sydney arrive at 12.00pm and 5.50pm	9:15–9:30 **Innovation Network Welcome – Juanita Hamparsum** 9:30–10:30 **Plenary speaker Dr. Greg Constable.** Chair: Mick Bange	9:15–10:15 **Plenary speaker: Dr. David McKenzie** Chair: Nilantha Hulugalle	8:45–9:45 **Plenary speaker: Prof. Myron Zalucki** Chair: Robert Mensah	Planes to Sydney
	10:30-11:00 Morning tea-Guy Roth introducing CRC work	10:15-10:45 CSD Morning tea	9:45-10:15 Morning tea	
	11:00-12:30 **Session 1 stream 1** Breeding & fibre quality (6) **Session1 stream 2 NRM** & modelling (6)	10:45-12:00 **Session 4 stream 1** Soil management (5) **Session 4 stream 2** Greenhouse gas emissions (5)	10:15-11:45 **Session 6 stream 1** BGIII & insect management (6) **Session 6 stream 2** Pest weeds & disease (6)	
	12:30-1:30 Lunch	12:00-1:00 Lunch	11:45-12:15 Lunch	
	1:30-3:00 **Session 2 stream 1** Breeding: a/biotic factors (6) **Session 2 stream 2** Post harvest :Fibre (6)	1:00-2:15 **Session 5 stream 1** Nutrition (5) **Session 5 stream 2** Stress Physiology (5)	**12:15-1:15 First AGM of the Association of Australian Cotton Scientists** 1:15-2:45 **Session 7 stream 1** Insect & Plant resistance (6) **Session 7 stream 2** Nematodes & disease (6)	
	3:00-3:30 Afternoon tea	2:15-2:45 Afternoon tea	2:45-3:00 Afternoon tea	
7 – 9:00 pm: **Welcome and finger food at the Crossing Theatre** Featuring harmonizers Harmony Inc.	3:30-4:30 **Session 3 stream 1** Future technologies (4) **Session 3 stream 2** Post harvest :Quality (4)	2:45-3:45 **Poster session**	3:00-4:00 **Session 8 stream 1** Pest: Helicoverpa (4) **Session 8 stream 2** Secondary insect pests (4)	
	10 min break	10 min break	10 min break	
	4:40–5:40 **Devil's advocate with a glass of wine**	3:55-4:55 **Devil's advocate with a glass of wine**	4:10–5:10 **Devil's advocate with a glass of wine**	
	5:40-7:15 **Poster session** and refreshments Own Dinner	4:57 Bus from Crossing Theatre to **Eulah creek excursion**. Featuring singer Helen Conroy	60 minute break 6:10 Bus from Crossing Theatre to **Conference Dinner at Craigdon Guesthouse.** Featuring bush band November Shorn	

Program Complete

	Sunday 8th September	
7:00-9:00 pm	Riverside room: Informal Welcome with finger food and Registration.	

	Monday 9th September – Breeding and Post Harvest	
8:30-8:40 am	Riverside room: Tea/ Coffee available. Auditorium lobby: Registration	Page No.
8:40 – 8:55 am	Auditorium: Welcome to Country.	
8:55 – 9:00 am	Auditorium: Housekeeping.	
9:00 – 9:15 am	Auditorium: Association of Australian Cotton Scientists Welcome - Mick Bange.	
9:15 – 9:30 am	Auditorium: Innovation Network Welcome – **Juanita Hamparsum.**	
Monday A 9:30 –10:30 am	Auditorium: **Plenary Talk** Chair: **Mick Bange** **Dr. Greg Constable;** Cotton breeding: past and future; conventional and molecular; and important interactions	13
10:30-11:00 am	Riverside room: Morning Tea – Guy Roth introducing collaborative CRC work	
Monday A 11:00-12:30 pm	Auditorium: Session 1 Stream 1 (6 Talks) **BREEDING: FIBRE QUALITY** Convener: **Robert Eveleigh**	
11:00-11:15	The pattern of cell wall polysaccharide deposition in cotton seed fibres differs for different species and in different seasons. **Filomena Pettolino**, Dina Yulia, Danny Llewellyn.	51
11:15-11:30	Molecular regulation of secondary cell wall deposition in cotton fibres. Colleen MacMillan, Liz Brill, Liz Dennis, **Danny Llewellyn**.	47
11:30-11:45	Pectin methylesterase and pectin remodelling differ in the fibre walls of two Gossypium species with very different fibre properties. **Qinxiang Liu**, Mark Talbot, Danny Llewellyn.	45
11:45-12:00	Does the lignin biosynthetic pathway have a role to play in cotton fibre quality? **Hannah Birke**, Filomena Pettolino, Colleen MacMillan, Danny Llewellyn.	28
12:00-12:15	Breeding progress and challenge for better quality cotton grown in a high yielding production system. **Shiming Liu**, Greg Constable, Warwick Stiller, Peter Reid.	44
12:15-12:30	Breeding strategies for improving fibre fineness while maintaining yield. **Jenny Clement**, Greg Constable.	32
Monday C 11:00-12:30 pm	Cinema 1: Session 1 Stream 2 (6 Talks) **NATURAL RESOURCE MANAGEMENT & MODELLING** Convener: **Jane Trindall**	
11:00-11:15	Development of a sensing system for automated cotton fruit load and vegetation estimation. **Alison McCarthy**, Nigel Hancock.	47

11:15-11:30	Combining GIS, remote sensing, and simulation modelling for spatial analysis of seed cotton yield and evapotranspiration in central Arizona, USA. **Kelly Thorp**, Douglas Hunsaker, Andrew French, Eduardo Bautista.	60
11:30-11:45	Building Geographic Information Systems for Australian cotton. **Peter Verwey**.	62
11:45-12:00	Predicting fiber quality using boll cutting. **Michael Bange**, Rob Long, Jane Caton, Rebecca Warnock, Darin Hodgson.	26
12:00-12:15	A new online tool for predicting in-season micronaire of cotton. **Sandra Williams**, Michael Bange, Greg Constable, Loretta Clancy.	65
12:15-12:30	Enhancing cotton crop simulation modelling to meet future research needs. **David Johnston**, Michael Bange.	40
12:30 - 1:30pm	Riverside room: Lunch	
Monday A 1:30 – 3:00 pm	Auditorium: Session 2 Stream 1 (6 Talks) **BREEDING: ABIOTIC/BIOTIC FACTORS** Convener: **Shiming Liu**	
1:30-1:45	Breeding for disease resistance in cotton: outcomes and challenges. **Warwick Stiller**, Peter Reid, Iain Wilson and Greg Constable.	58
1:45-2:00	Improving disease resistance in cotton using marker assisted breeding. Nicole Mossfield, Tanya Phongkham, Vanessa Gillespie, Qian-Hao Zhu, Warwick Stiller, Danny Llewellyn, **Iain Wilson**.	49
2:00-2:15	Discovery of single nucleotide polymorphisms for applications in cotton genetics and breeding. **Qian-Hao Zhu**, Andrew Spriggs, Jen Taylor, Danny Llewellyn, Iain Wilson.	66
2:15-2:30	Rapid field-based phenotyping for breeding water-use efficient cotton. **Warren Conaty**, Greg Constable, Alan Thompson.	33
2:30-2:45	Heat tolerance of cotton. **Nicola Cottee,** Michael Bange, Iain Wilson.	34
2:45-3:00	Mechanisms of plant resistance to silverleaf whitefly in cotton. **Junji Miyazaki,** Warwick Stiller, Lewis Wilson.	49
Monday C 1:30 – 3:00 pm	Cinema 1: Session 2 Stream 2 (6 Talks) **POST HARVEST:FIBRE** Convener: **Rene van der Sluijs**	
1:30-1:45	Morphology and tensile properties of bast fibres extracted from cotton stalks. **Menghe Miao**, Alban Yzombard, Stuart Gordon.	48
1:45-2:00	Some quirks of the HVI: Opportunities for improved fibre strength and elongation by simply managing fibre length! **Geoffrey Naylor,** Chris Delhom, Xiaoliang (Leon) Cui, Jean-Paul Gourlot, James Rodgers.	50
2:00-2:15	Effects of cotton cellulose structure and fibre surface substrate interactions on dye uptake. **Genevieve Crowle**.	35
2:15-2:30	An assessment of alternative cotton fibre quality attributes and their influence on yarn strength. **Robert Long**, Michael Bange, Christopher Delhom, Jeffrey Church, Greg Constable.	46
2:30-2:45	A new concept for cotton fibre elongation. **Shouren Yang**, Stuart Gordon.	66
2:45-3:00	Impact of harvest aid timing and machine spindle harvesting on neps in upland cotton. Michael Bange, **Robert Long**.	27
3:00-3:30 pm	Riverside room: Afternoon Tea	

Monday A 3:30 –4:30 pm	Auditorium: Session 3 Stream 1 (4 Talks) **FUTURE TECHNOLOGIES** Convener: **Lewis Wilson**	
3:30-3:45	Future Biotechnologies. **Danny Llewellyn**.	45
3:45-4:00	Breeding of elite Genuity Bollgard III® cultivars. **Warwick Stiller,** Greg Constable, Shiming Liu.	58
4:00:4:15	Understanding the molecular basis of cotton fibre differentiation and initiation. **Sally-Ann Walford**, Frank Bedon, Lili Tu, Danny Llewellyn, Elizabeth Dennis.	63
4:15-4:30	Development of mutagenised populations for the genetic dissection of important. **Shiming Liu**, Linda Tabe, Filomena Pettolino, Danny Llewellyn, Liz Dennis , Greg Constable, Warwick Stiller.	44
Monday C 3:30 –4:30 pm	Cinema: Session 3 Stream 2 (4 Talks) **POST HARVEST: QUALITY CONTROL** Convener: **David Anthony**	
3:30-3:45	Comparing cotton fibre quality from conventional and round module harvesting methods. **Rene van der Sluijs**, Robert Long, Michael Bange.	62
3:45-4:00	On-line cotton contamination sensors for Australian gins. **Andrew Krajewski**, Stuart Gordon, Andrew Tulloh, David Fox, Neale Gibbons, Scott Barnes.	43
4:00:4:15	Chasing the glass transition of cotton. **Chantal Denham**, Mickey Huson, Stewart Gordon, Xungai Wang.	35
4:15-4:30	Scanning probe microscopy: more than just a pretty picture. **Mickey Huson**.	40
4:30-4:40	10 min Break	
Monday A 4:40-5:40 pm	Auditorium: Devil's advocate with a glass of wine. Adjudicator: Mary Whitehouse, Devil's advocates: David Anthony, Michael Bange	
Monday RR 5:40-7:15 pm	River room: Poster Session	
	Own Dinner	

	Tuesday 10th September - Agronomy	
8:45 am	Riverside room: Tea/ Coffee available Auditorium lobby: Registration	
9:00-9:15am	Auditorium: Housekeeping.	
Tuesday A 9:15-10:15 am	Auditorium: **Plenary Talk** Chair: ***Nilantha Hulugalle*** **Dr. David McKenzie**; Soil appraisal and management in the cotton industry – achievements so far and future opportunities	14
10:15-10:45 am	Riverside room: CSD sponsored Morning Tea	
Tuesday A 10:45-12:00 pm	Auditorium: Session 4, Stream 1 (6 talks) **SOIL MANAGEMENT** Convener: Allan Williams	
10:45-11:00	Types of deep drainage under irrigated cotton farming systems on a cracking clay soil. **Anthony Ringrose-Voase**, Tony Nadelko.	53
11:00-11:15	The potential for biodegradable film to improve cotton establishment in cool regions. **Michael Braunack**, Jo Price, Jorian Milyard.	29

11:15-11:30	Soil quality and energy use in irrigated cotton-based cropping systems. **Nilantha Hulugalle**, Tim Weaver, Lloyd Finlay, Viliami Heimoana.	39
11:30-11:45	Developing a National framework to evaluate indicators for soil health monitoring. **Brajesh Singh**.	56
11:45-12:00	Legacy soil and ancillary data: a "not so" lost opportunity for improved soil resource mapping and management? **John Triantafilis.**	61
Tuesday C 10:45-12:00 pm	Cinema 1: Session 4, Stream 2 (5 talks) GREENHOUSE GAS EMISSIONS Convener: **Paula Jones**	
10:45-11:00	Impact of elevated CO_2 and temperature on cotton growth and physiology under well-watered conditions. **David Tissue**, Renee Smith, Katie Broughton, Remko Duursma, Paxton Payton, Michael Bange.	61
11:00-11:15	Interactive effects of elevated [CO_2], warming and water deficit on cotton physiology and growth. **Katie Broughton**, Renee Smith, Daniel Tan, Remko Duursma, Paxton Payton, Michael Bange, David Tissue.	30
11:15-11:30	Irrigated cotton crop phenology in a new temperature regime. **Qunying Luo**, Michael Bamge, Loretta Clancy.	46
11:30-11:45	AusAgLCI - the business case for investment in national life cycle inventory for cotton **Sandra Eady,** Helen Cruypenninck.	36
11:45-12:00	Cotton-corn farming systems in the Namoi Valley: A life cycle assessment. George Quigley, Philippa Brock, Nilantha Hulugalle, **Daniel Tan**.	52
12:00 - 1:00pm	Riverside room: Lunch	
Tuesday A 1:00 - 2:15 pm	Auditorium: Session 5, Stream 1 (5 talks). NUTRITION Convener: **Daniel Tan**	
1:00-1:15	Is soil nutrient supply at breaking point with recent high yields? **Chris Dowling**.	36
1:15-1:30	Crop rotation influences microbial activity, diversity and nitrogen mineralization in cotton soils. **Gupta Vadakattu**, Ian Rochester.	38
1:30-1:45	The nutritional hypothesis for fruit shedding and cutout still applies today. **Rose Brodrick**, Michael Bange, James Quinn, Greg Constable.	30
1:45-2:00	Where do boll nutrients come from? The contribution of individual leaves to the Nitrogen and Potassium in a mature boll. **Meredith Conaty** Ian Rochester.	33
2:00-2:15	A revised NutriLOGIC program to better predict Nitrogen fertiliser requirement. **Ian Rochester**.	54
Tuesday C 1:00 - 2:15 pm	Cinema 1: Session 5 Stream 2 (5 talks). STRESS PHYSIOLOGY Convener: **Janelle Montgomery**	
1:00-1:15	Water-use efficiency in irrigated cotton production. **Warren Conaty**, Greg Constable.	34
1:15-1:30	Growth and yield of cotton in response to waterlogging. **Michael Bange**, Steve Milroy	27

1:30-1:45	Aminoethoxyvinylglycine (AVG)-induced improved growth and fruit retention mitigate yield losses in waterlogged cotton. **Ullah Najeeb**, Daniel Tan, Michael Bange.	50
1:45-2:00	Understanding the underlying physiology and photosynthetic biochemistry contributing to thermotolerance and water use efficiency amongst cotton genotypes. **Robert Sharwood**, Oula Ghannoum, Balasaheb Sonawane, Michael Bange, David Tissue.	55
2:00-2:15	The influence of plant competition on the timing of crop maturity in cotton. **Rose Brodrick**, Michael Bange, Steve Milroy, Graeme Hammer.	29
2:15-2:45 pm	Riverside room: Afternoon Tea	
Tuesday A 2:45-3:45 pm	Auditorium: Poster Session with mini presentations	
	Ten minute break	
Tuesday A 3:55-4:55 pm	Auditorium: Devil's advocate with a glass of wine Adjudicator: Brajesh Singh, Devil's advocates: Mark Hickman, Karen Kirkby	
4:57 - 9:30	**EULAH CREEK EXCURSION**	

	Wednesday 11th September - Pest Management	
8:15 am	Riverside room: Tea/ Coffee available Auditorium lobby: Registration	
8:30 – 8:45 am	Auditorium: Housekeeping	
Wednesday A 8:45-9:45 am	Auditorium: **Plenary Talk** Chair: **Robert Mensah** **Prof. Myron Zalucki**; Thirty odd years of research on Helicoverpa biology and ecology; what have we gained?	15
9:45-10:15am	Riverside room: Morning Tea	
Wednesday A 10:15-11:45	Auditorium: Session 6, Stream 1 (6 talks) **BOLLGARD III & INSECT MANAGEMENT** Convener: Tracey Leven	
10:15-10:30	A new semiochemical biopesticide for cotton pest management. **Robert Mensah**, Christopher Moore, Nick Watts, Myrna Deseo, Peter Glennie, Angela Pitt.	48
10:30-10:45	The ecology of facultative fungal endophytes in cotton agroecosystems. **Gregory Sword**.	59
10:45-11:00	Sulfoxaflor: a new mode of action for the management of cotton pests in Australia. Robert Annetts, **Paul Downard,** James Thomas.	25
11:00-11:15	Fruit retention and distribution in Bollgard III, Bollgard II and Conventional cotton crops across the Australian cotton growing regions. **Meredith Conaty.**	32
11:15-11:30	Assessment of the efficacy of insect protected Bollgard®III, Roundup Ready Flex® cotton against *Helicoverpa* spp across Australian cotton growing regions. **Kristen Knight**	42
11:30-11:45	Target and non-target effects of novel "triple-stacked" Bt-transgenic cotton on canopy arthropod communities. **Mary Whitehouse**, Lewis Wilson, Andrew Davies, Dominic Cross, Penny Goldsmith, Alan Thompson, Steve Harden, Geoff Baker.	64
Wednesday C 10:15-11:45	Cinema 1: Session 6, Stream 2 (6 talks) **PEST WEEDS & DISEASE** Convener: Linda Smith	

10:15-10:30	Emergence of four weed species in response to rainfall and temperature. **Michelle Keenan**, Jeff Werth.	41
10:30-10:45	Glyphosate resistance in Australian cotton and beyond. **Graham Charles.**	31
10:45-11:00	Managing herbicide resistance in cotton systems: have we covered everything? **Jeff Werth**, David Thornby, Steve Walker.	63
11:00-11:15	The population genomics of glyphosate resistant weeds. **James Hereward.**	39
11:15-11:30	A new model for testing field-level epidemiology of herbicide resistance in cotton. **David Thornby**, Jeff Werth	60
11:30-11:45	Can sustainable biological disease suppression be achieved in cotton farming systems? **Gupta Vadakattu**, Linda Smith, Karen Kirkby.	37
11:45-12:15	Riverside room: Lunch	
12:15-1:15	Auditorium: First annual general meeting of the Association of Australian Cotton Scientists	
Wednesday A 1:15 -2:45 pm	Auditorium: Session 7, Stream 1 (6 talks) INSECT & PLANT RESISTANCE Convener:Paul Grundy	
1:15-1:30	Long-term patterns of Helicoverpa resistance to conventional insecticides: implications for the role of sprayed refuges in Bt transgenic cotton. **Lisa Bird**.	28
1:30-1:45	Refuge crop performance as part of the Bt resistance management strategy for Helicoverpa spp. **Geoff Baker**, Colin Tann.	26
1:45-2:00	Maintaining and improving refuges in cotton production systems. **Mary Whitehouse**.	64
2:00-2:15	Behavioral ecology of wolf spiders in cotton fields: implications for the control of insecticide-resistant cotton bollworms. **Dalila Rendon**, Mary Whitehouse, Phillip Taylor	53
2:15-2:30	Understanding the clonal structure and pesticide resistance status of Australian cotton aphid *Aphis gossypi*i Glover. Yizhou Chen, Flavie Vanlerberghe-Masutti, Lewis Wilson, Idris Barchia, Martin McLoon, Tanya Smith, **Grant A Herron**.	31
2:30-2:45	Inducible tolerance to Bacillus thuringiensis toxins and emamectin benzoate in lepidopteron insects. **Mahbub Rahman**, Otto Schmidt, Greg Baker, Mary Whitehouse, Mike Keller, Rick Roush.	52
Wednesday C 1:15 -2:45 pm	Cinema 1: Session 7, Stream 2 (6 talks) NEMATODES & DISEASE Convener: Lily Pereg	
1:15-1:30	Three decades of cotton disease surveys in NSW, Australia. **Karen Kirkby**, Peter Lonergan, Stephen Allen	42
1:30-1:45	Managing Fusarium wilt of cotton with rotation options. **Linda Scheikowski**., Linda Smith, John Lehane.	54
1:45-2:00	The Influence of N, P and K on Severity of Fusarium Wilt of cotton. **Linda Smith**, Linda Scheikowski, John Lehane.	57
2:00-2:15	Reniform nematode (*Rotylenchulus reniformis* Linford and Oliveira, 1940): First detections in Australian cotton and survey in central Queensland. Linda Smith, Jennifer Cobon, Wayne O'Neill, **Bartley Bauer**, Linda Scheikowski, John Lehane.	57
2:15-2:30	Cotton seedling establishment in southern New South Wales. **Stephen Allen**.	25

2:30-2:45	Cotton bunchy top virus and other relatives. **Murray Sharman**, Lewis Wilson, Tanya Smith, Matt Webb, Paul Grundy, Marc Ellis, Cherie Gambley, John Thomas, Marc Giband, Nelson Suassuna, Jean-Louis Belot, Siwilai Lapbanjob, Kanjana Warawichanee.	55
2:45-3:00 pm	Riverside room: Afternoon Tea	
Wednesday A 3:00-4:00 pm	Auditorium: Session 8, Stream 1 (4 talks) **Pest: Helicoverpa** Convener: Peter Gregg	
3:00-3:15	Helicoverpa spp. response to landscape structure. **Cate Paull,** Nancy Schellhorn.	51
3:15-3:30	The Ecology of *Helicoverpa punctigera*: overwintering in local fields and Inland Queensland? **Kris Le Mottee**, Peter Gregg, Alice Del Socorro.	43
3:30-3:45	The analysis of host-plant origin using the triacylglycerol content of *Helicoverpa armigera*. **Ben Greatrex**, Peter Gregg, Alice del Socorro, Mujibur Bhuiyan, Robert Murison.	37
3:45-4:00	Making use of the *Helicoverpa armigera* genome. The Helicoverpa genome consortium, Wee Tek Tay, Miguel Soria, **Thomas Walsh**, Danielle Thomazoni, Pierre Silvie, Gajanan Behere, Craig Anderson.	59 59
Wednesday C 3:00-4:00pm	Cinema1: Session 8, Stream 2 (4 talks) **Secondary Insect Pests** Convener: Grant Heron	
3:00-3:15	The effects of aphids on photosynthesis in cotton. **Simone Heimoana**, Lewis Wilson, Doug George, Greg Constable.	38
3:15-3:30	The fate of honeydew in cotton. **Lewis Wilson**, Simone Heimoana, Michael O'Shea, Paul De Barro, Michael Priest.	65
3:30-3:45	Understanding Solenopsis mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) damage and within-plant distribution on Bollgard® cotton. **Moazzem Khan**, Kristy Byers, Gail Spargo.	41
3:45-4:00	How predictable are the behavioral responses of insects to herbivore induced changes in plants? A case study into the complex interactions between three thrips species and their host plant cotton. **Rehan Silva**, Michael Furlong, Gimme Walter, Lewis Wilson.	56
	Ten minute break	
Wednesday A 4:10-5:10 pm	Auditorium: Devil's advocate with a glass of wine Adjudicator:Rob Eveleigh, Devil's advocates: Warwick Stiller, Peter Gregg	
	60 minute break	
6:10 – Late	Buses to Conference **Dinner at Craigdon Guesthouse.**	

	Posters grouped into related sessions	
	Session 1, Stream 2: Natural Resource Management & Modelling	

Cotton seedling establishment in southern New South Wales

Stephen J. Allen

Cotton Seed Distributors Ltd

Stream: *Pest Management* **Oral**

The area planted to cotton in the Lachlan and Murrumbidgee Valleys of southern NSW increased from approximately 3,000 hectares in 2008/09 to over 60,000 hectares in 2011/12 and an estimated 40,000 hectares in 2012/13. A significant challenge for successful cotton production in these areas is seedling establishment in the cooler climate of southern NSW. To delay planting until temperatures are optimum for germination and emergence results in a reduced yield potential. The objective of this study was to identify and quantify those factors affecting seedling establishment. Commercial cotton crops near Condobolin, Hillston, Griffith and south of Darlington Point in southern NSW were inspected in the spring of 2012. Seed beds were opened by removal of the soil on one side of the row and adjacent to the plant line. This enabled direct observation of the germinating seedlings and assessment of pre- and post-emergent damping-off, seed rot, hard seed, wire-worms and cut-worms, compaction, crusting, allelopathy, fertiliser burn and persistent seed coats as well as seed depth, seed rate, seedling height and true leaf production. Daily minimum soil temperatures and daily rainfall were also monitored during the planting period. Pre- and post-emergent damping-off and seed rot were identified as the most significant factors coupled with the occurrence of rain-fall events and low soil temperatures. Seedling establishment was consistently better on the northern side of East-West beds. The lowest establishment (31.9%) occurred when seed was planted into a dry seed-bed and watered and then exposed to a two day rainfall event and cold temperatures.

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Sulfoxaflor: A new mode of action for the management of cotton pests in Australia

Robert Annetts[1] **Paul Downard**[1] and James Thomas[2]

[1] Dow AgroSciences Toowoomba, QLD, Australia [2] Dow AgroSciences Indianapolis, IN

Stream: *Pest Management* **Oral**

Sulfoxaflor (Transform® insecticide) is a broad-spectrum sap-feeding insecticide from Dow Agrosciences. It is expected to be registered for use in the 2013-14 Australian cotton-growing season for control of *Creontiades dilutus*, *Aphis gossypii*, and *Trialeurodes vaporariorum*. Excellent knock-down and extended residual efficacy has been demonstrated in field trials carried out in Australia (Annetts & Elias 2012). Trials have showed that Transform® is relatively safe to many beneficial insects and will not flare mites. Sulfoxaflor, a member of the new class of chemicals called sulfoximines, has been placed in a new IRAC mode of action subgroup (4C). The mode of action of sulfoxaflor is agonism at the insect nicotinic acetyl-choline receptor (nAChR) and extensive testing has demonstrated a robust lack of cross-resistance between sulfoxaflor and other insecticide classes. Excellent efficacy on aphids resistant to other chemistry groups has been demonstrated in the laboratory on *A. gossypii* and in the field on *Myzus persicae* in Australia as well as many other species around the globe. The lack of cross resistance is associated with the novel sulfoximine functional group of sulfoxaflor making it chemically distinct from other classes of insecticides. This unique chemical structure prevents sulfoxaflor from break-down by CYP6G1 monooxygenases in resistant insects. Sulfoxaflor also exhibits unique interactions with the nAChR receptor which may contribute to the lack of cross-resistance. This presentation will discuss sulfoxaflor as a critical tool for insect resistance management in Australian cotton focusing on the MOA of sulfoxaflor and demonstrated lack of cross resistance to other commonly used insecticides. Transform® is a trademark of The Dow Chemical Company (“Dow“) or an affiliated company of Dow

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Refuge crop performance as part of the Bt resistance management strategy for *Helicoverpa spp.*

Geoff Baker & Colin Tann

CSIRO Ecosystem Sciences, Canberra & Narrabri

Stream: *Pest Management* **Oral**

Bt resistance within insect pests, such as *Helicoverpa spp*., is a major threat to the deployment of Bt cotton crops world-wide. Refuge crops are therefore commonly grown along with Bt cotton to generate large numbers of Bt susceptible insects, thus reducing the risk of resistance. In Australia, pigeon pea and non Bt cotton are the refuge options available to growers. Because pigeon pea was assessed as having twice the capacity to produce Helicoverpa moths as unsprayed, non Bt cotton when Bt cotton was first deployed in Australia (1996), only half the amount (area) of it is required to be grown here. The agronomy, insecticide use, varieties of Bt cotton (now based on two Bt genes [Bollgard II®], compared with the original single gene [Ingard®] varieties) and farmer profit margins have, however, changed substantially since then. This has led to questioning of the continued relativities and best management practices involving these refuge crops. This paper assesses the performance of pigeon pea and non-Bt cotton refuges in cotton production landscapes in eastern Australia since 1996. Pupae abundance is used as a surrogate for moth production. Pigeon pea has maintained its substantial superiority over unsprayed, non Bt cotton as a refuge generator of Helicoverpa throughout both the Ingard and Bollgard II eras. These results will be discussed in concert with data demonstrating long term trends in the landscape-scale abundance of these pests, as well as their natural enemies (parasites in particular).

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Predicting fiber quality using boll cutting

Michael Bange, Robert Long, Jane Caton, Rebecca Warnock and Darin Hodgson.

CSIRO Plant Industry

Stream: *Agronomy and Soils* **Oral**

To optimise yield and fibre quality, boll cutting (investigating seed coat colour) is used by cotton managers to determine when crops are mature and ready for chemical harvest aid application. Three field experiments were undertaken in different seasons that systematically varied the timing of harvest aid application to vary the amount of immature, mature, and open bolls to assess (i) fibre quality of open, mature, and immature bolls, (ii) the variation that exists within and across seasons, and (iii) if quality at the time of harvest aid application of immature, mature, and open bolls is related to final micronaire. Within seasons, quality varied by up to 1.06-1.53 for micronaire, 0.13-0.14 for maturity ratio, and 28.2-30.7 Î¼g m^{-1} for linear density among immature, mature, and open bolls. When data were combined across all seasons relationships were developed that predicted micronaire at harvest using micronaire (r2 > 0.73) and its components together (maturity and linear density) (r2 > 0.81) of the immature bolls measured at harvest aid application. Relationships were improved when percent open bolls was included as a factor in the regressions (r2 > 0.88). Combined with responses that predict the influence of harvest aid timing on quality, this knowledge could be used to estimate harvest aid timing influences on micronaire thus avoiding discounts. This concept is currently being refined by evaluating the use of targeted sampling times leading up to crop maturity.

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Growth and yield of cotton in response to waterlogging

M. Bange and S. Milroy

CSIRO Plant Industry

Stream: *Agronomy and Soils* **Oral**

Cotton is known to be poorly adapted to waterlogged conditions. Three field experiments were conducted in which cotton was subjected to waterlogging by extending the duration of irrigation events. Consistent with the literature, yield loss was associated with reduced boll number (R^2=0.82). The reduction in boll number was commensurate with the reduction in total plant dry matter caused by lower radiation use efficiencies (RUE). Leaf photosynthesis (Pn) was related to specific leaf nitrogen (SLN) (before ontogenetic effects were taken into account) and soil O2 status. Values of Pn were less with lower SLN and soil O2 status however, these changes could not entirely explain suppression in RUE calculated for short time periods during crop growth. As the season progressed and after repeated waterlogging the Pn response to soil O2 status also changed suggesting some degree of acclimation. These results suggest to be able to scale from the impact on Pn to the impact on crop RUE will require the changes in specific leaf nitrogen, light and Pn to be measured at various heights within the canopy during the period of hypoxia and subsequent recovery.

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Impact of harvest aid timing and machine spindle harvesting on neps in upland cotton

Michael.P. Bange and **Robert L. Long**

CSIRO Plant Industry, CSIRO Materials Science and Engineering

Stream: *Post Harvest* **Oral**

Neps are fiber entanglements created during the mechanical processing of cotton and are often associated with immature fibers. Even in small amounts neps can affect textile quality and cotton marketability. Machine harvesting, lower fiber linear density (fineness), and more immature bolls at harvest, are factors that contribute to neps. However, it is not clear whether differences in fiber linear density or immature bolls at harvest combine with harvest method to substantially affect neps. The aim of this study was to compare machine spindle and hand-harvested cotton collected from four field studies with treatments that differed in % immature bolls and fiber linear density at harvest resulting from differences in harvest aid timing and to test for statistical interactions. By systematically varying the timing of harvest aids to cease crop growth, removing fruiting branches, or both, differences in % immature bolls and fiber linear density were generated. In all studies spindle harvesting increased neps, but there were no significant statistical interactions between the harvest method with harvest aid timing or branch removal treatments. When all measurements of neps were combined across studies there was a multiple regression that explained the level of neps with harvest method and fiber linear density (R^2=0.66). These responses supported the individual season analyses finding no statistical interaction of harvest method with either variable. Spindle harvesting increased neps by an average of 53 count/g compared to hand-harvesting. Identifying reasons for differences in nep levels between cotton growing regions, may assist in developing strategies to reduce neps.

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Long-term patterns of Helicoverpa resistance to conventional insecticides – implications for the role of sprayed refuges in Bt transgenic cotton resistance management

Lisa Bird and Gina Bange

NSW Department of Primary Industries

Stream: *Pest Management* **Oral**

Bt transgenic cotton has revolutionized cotton production in Australia most notably by reducing reliance on conventional insecticides for control of Helicoverpa. This is a direct result of deployment of Bollgard II (expressing Cry1Ac and Cry2Ab insecticidal toxins from the bacterium *Bacillus thuringiensis*) which is highly efficacious against Helicoverpa species, and indirectly through positive ecological consequences of Helicoverpa population suppression, and landscape-scale effects on beneficial species abundance. Widespread adoption of transgenic cotton imposes considerable selection pressure on Helicoverpa populations. As part of a pre-emptive resistance management strategy, growers are required to plant non-transgenic refuges for generating sufficient numbers of susceptible Helicoverpa moths to dilute Bt resistance. Currently, unsprayed refuges (pigeon pea or cotton) are used in favour of sprayed refuges (cotton) as they produce higher numbers of Helicoverpa per hectare, thus requiring smaller refuge sizes. However, poor management practices can compromise high productivity ratios in unsprayed refuges. On the other hand sprayed refuges may be advantageous for providing a profit-driven incentive for refuge management, while reducing resistance risk to Bt toxins through redistribution of selection pressure across multiple insecticides. Over the last decade a number of selective insecticides have become available for cotton pest control. Unlike broad-spectrum insecticides, selective products have remained extremely effective against Helicoverpa, with no detection of field resistance. Low resistance risk, high IPM-compatibility and favourable cross-resistance profiles to known Bt-resistance genotypes supports a re-assessment of the benefits of sprayed cotton refuges managed with IPM principles as a viable refuge choice in future Bollgard resistance management programs.

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Does the lignin biosynthetic pathway have a role to play in cotton fibre quality?

Hannah Birke, Filomena Pettolino, Colleen MacMillan and Danny Llewellyn

CSIRO Plant Industry

Stream: *Breeding* **Oral**

A secondary cell wall is an important characteristic of several plant cells. It mainly consists of cellulose and other structural polysaccharides but additional components like protein and lignin significantly contribute to its function. Deposition of lignin into the secondary cell wall, for example, provides mechanical support, allows water transport and protects against biotic and abiotic stresses. Cotton (*Gossypium hirsutum*) seed fibres are elongated single cells emerging from the seed epidermis and are characterised at maturity by an extremely thickened secondary cell wall. This seed fibre secondary cell wall, however, differs from other secondary cell walls in cotton as it lacks significant amounts of lignin. Transcript analysis of cotton seed fibre has suggested that at least some of the enzymes involved in lignin biosynthesis are expressed at the transition to secondary cell wall synthesis. This intriguing observation raises the question of what these enzymes are doing if not making lignin as in other secondary cell wall types in cotton. Furthermore, engineered lignification of the seed fibre secondary cell wall might confer favourable properties from a commercial point of view. This study therefore aims to answer whether the complete lignification machinery is present in cotton seed fibres, whether another lignin-like compound rather than lignin is synthesised and, finally, whether manipulation of lignin deposition alters seed fibre properties (e.g. water resistance, strength, elasticity).

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The potential for biodegradable film to improve cotton establishment in cool regions

Michael Braunack[1], Jo Price[1] and Jorian Milyard[2]

[1]CSIRO, Plant Industry , [2]CSD

Stream: *Agronomy and Soils* **Oral**

Poor crop establishment compromises productivity and may necessitate the expense of replanting. In cool regions, production can be limited by the need to replant due to prolonged cold conditions. New biodegradable thin films provide an opportunity to overcome this limitation without the risk of contaminating lint at harvest. The concept is to plant cotton and apply film in one pass, with the film degrading as cotton emerges so the crop grows as if planted with no film. Preliminary results suggest the films enhance early establishment however, the film used did not breakdown as expected. Pilot studies undertaken in the Namoi Valley has demonstrated that thin film promoted early and uniform crop emergence by increasing soil temperature and retaining seedbed moisture compared to bare soil. Following emergence cotton was not able to penetrate the film due to excessive temperatures under the film, therefore crop growth and yield benefits have not been adequately determined.

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The influence of plant competition on the timing of crop maturity in cotton

Rose Brodrick[1], Michael Bange[1], Steve Milroy[1] and Graeme Hammer[2]

[1] CSIRO Plant Industry, [2] The University of Queensland

Stream: *Agronomy and Soils* **Oral**

A key challenge to developing production systems with earlier maturity is that there is generally a yield penalty. Ultra-narrow row (UNR) cotton, a production system with rows spaced less than 40 cm apart, was proposed as a system for earlier maturity without substantial yield loss. In theory, UNR cotton, with fewer bolls per plant but more plants/m2, should lead to earlier maturity without sacrificing yield, with fewer early bolls to grow to maturity on each plant. Experiments comparing UNR with 1m row spacing in Australia found on average a 15.9% increase in yield in UNR, however, there were no differences in crop maturity. Despite UNR having smaller plants with fewer bolls these bolls were not set and matured over a shorter time period compared to the larger plants in conventionally spaced crops. The competition between plants in UNR crops restricted dry matter production per plant very early in the crop cycle, slowing node and site production, resulting in fewer fruit per plant that were set over the same time period as the fruit in the conventionally spaced crops. These studies highlighted that for improvements in yield and earlier maturity to be generated with changes in plant population the rate of site production must be greater on a per plant basis as well as at crop level.

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The nutritional hypothesis for fruit shedding and cutout still applies today

Rose Brodrick[1], Michael. Bange[1], James Quinn[2] and Greg. Constable[1]

[1]CSIRO Plant Industry, [2]Cotton Seed Distributors

Stream: *Agronomy and Soils* **Oral**

As cotton is an indeterminate plant, there is no morphological limit to its size and development. As long as conditions are favourable, vegetative production of new main-stem and fruiting branches could continue indefinitely. However, the plant stops producing new leaves and fruiting sites (termed cutout) due to the demand on the resource supply by the developing bolls leaving no surplus for the initiation of new fruiting sites. The hypothesis was termed the nutritional hypothesis for fruit shedding in 1955 by Eaton and was supported by detailed investigations into fruiting dynamics in the 70s and early 80s. More recent investigations into cotton crop maturity and plant population studies were used to investigate the hypothesis from a growth dynamics perspective. Cutout in a range of treatments was calculated as the time when total crop growth rates were equal to when fruit growth rates (supply = demand). These times were then related to cotton maturity and measures of NAWF (as a surrogate for estimating cutout) to assess if the hypothesis explained the timing of cutout. Significant and strong linear relationships between these measures were derived supporting the nutritional hypothesis. The hypothesis was then applied to investigations of responses of fruit retention to their carrying capacities in high yielding modern crops. Today, as in the past the nutritional hypothesis is highly relevant in explaining reasons for difference in growth and yield in response to environment, changes to agronomic management, and cultivar differences.

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Interactive effects of elevated [CO_2], warming and water deficit on cotton physiology and growth

Katie Broughton[A, C], Renee Smith[B], Daniel Tan[A], Remko Duursma[B], Paxton Payton[D], Michael Bange[A, C], David Tissue[B]

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Stream: *Agronomy and Soils* **Oral**

Industrial-age changes in climate – elevated [CO_2], warmer temperatures, and altered precipitation - may have significant impacts on the physiology, growth, and yield of cotton. Elevated [CO_2] generally increases mass production, leaf area, photosynthetic rate, lowers stomatal conductance, and hence, increases leaf-level water use efficiency. Warmer temperatures may accelerate plant development, but also increase water use. Here, we studied the interactive effects of elevated [CO_2], warmer temperature, and soil water deficit to assess the effects of projected climate change on cotton productivity. Cotton cultivar Sicot 71BRF was grown at two [CO_2] (400 and 640 ppm) and two temperature (28/17 and 32/21 day/night ^{o}C) treatments in environmentally controlled glasshouses at the University of Western Sydney. Plants were either well-watered or exposed to two soil drying and recovery cycles. At ambient temperatures (28/17^{o}C), growth in elevated [CO_2] resulted in increased biomass production and increased whole plant water use efficiency compared to plants grown under ambient [CO_2]. Total plant water use was higher in elevated temperature, and generally not affected by elevated [CO_2]. Drought eliminated the positive effects of elevated [CO_2] on biomass production and physiology. Overall, elevated [CO_2] increased plant production in well watered conditions, but these positive attributes were eliminated at high temperature and drought conditions, suggesting that in future drier climates, cotton production may be reduced. Research is continuing to examine the effect of elevated [CO_2] on cotton in the field.

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Glyphosate resistance in Australia and beyond

Graham Charles

NSW DPI

Stream: *Pest Management* **Oral**

World agriculture is in deep trouble, with the loss of many herbicides imminent. Australian cotton is well placed but won't remain so unless its proactive. The World.• 24 weed species with resistance to glyphosate In the US: • First resistance in 2005 • Area increasing 25%/year • 61.2 million ha of resistant weeds • Fields are overgrown and hand-hoeing common • Expecting complete failure soon.WHY? • Farmers exclusively used glyphosate until it was too late.Water hemp: • Huge problem in the mid-west • Resistance to 4 - 6 modes of action. Giant ragweed: • 1 fields in 2008 • 61 fields in 2011 • 48X resistance. Canadian fleabane: • 8 fields in 2010 • 76 fields in 2011 • 48X resistance. Ryegrass: • A wide range in resistance levels • Indicates multiple mechanisms.Palmer amaranth in RR crops:• 1 resistant plant in 2004 • 3 years later the field was unmanageable • Now resistance in all southern states • Using Groups G & K and expecting resistance soon • spending $72 - $300/ha chipping • In cotton using glyphosate + pre-emergence residuals + residual in-crop every 2 weeks to canopy closure. One grower: • Kept chipping • Spends $7/ha chipping • Has no resistance! Conclusions: * Resistance develops even when an IWM approach is used * Non-target site mutations are most and can stack-up over generations. *Resistant is inevitable, but is manageable in a true IWM system. * Provided there is attention to detail.

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Understanding the clonal structure and pesticide resistance status of Australian cotton aphid *Aphis gossypii* Glover.

Yizhou Chen, Flavie Vanlerberghe-Masutti, Lewis J Wilson, Idris Barchia, Martin O McLoon, Tanya Smith and **Grant A Herron**

NSW Department of Primary Industries, Elizabeth Macarthur Agricultural Institute, Narellan, NSW, Australia INRA, UMR1062 CBGP,Montferrier-sur-Lez, France CSIRO Plant Industry and Cotton Catchment Communities Cooperative Research Centre, Narrabri, NSW, Australia

Stream: *Pest Management* **Oral**

Aphis gossypii is an important pest of cotton that has developed resistance to many chemicals. Its management may be improved by the better understanding of its clonal structure. We used 8 microsatellite markers to profile Australian *A. gossypii* field isolates (strains) collected from 55 plant species within major Australian cotton-producing regions. Each isolate was also tested for pirimicarb resistance by genotyping ACE1 (acetylcholinesterase) and/or bioassay. Overall, the genetic diversity of the isolates was low and there were only 13 multilocus genotype (MLG) groups found in a total of 936 aphids, suggesting asexual reproduction. Three MLGs (Aust-01, Aust-02 and Aust-04) represented 78% of all aphids tested. Aust-01 (41%) and Aust-02 (18%) were linked to the ACE1 S431F mutation and found on cotton and a range of hosts. Aust-04 (19%) hosted mainly on cotton (but also Asteraceae and Malvaceae) was predominantly susceptible to pirimicarb. Our study demonstrated that any strategy to control *A. gossypii* and manage pirimicarb resistance in cotton should target *A. gossypii* strains of all MLG types residing on any plant species. To enhance our ability to detect resistance we are now developing new molecular based technology that can monitor all known resistance mutations in any cotton pest species. To aid this we will develop a DNA library that contains all known resistance causing target mutations. Once developed our library can be used to identify resistance allele(s) in pests where the resistance gene sequences are currently not available such as green mirid *Creontiades dilutus* or two spotted mite *Tetranychus urticae*.

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Breeding strategies for improving fibre fineness while maintaining yield

Jenny Clement and Greg Constable

CSIRO Plant Industry

Stream: *Breeding* **Oral**

Cotton yarn quality is dependent on its fibre quality. Improvements to fibre length, strength and linear density (fineness) promote premium yarn quality and reduced mill production costs. However fibre quality improvements are negatively associated with yield and therefore are not a priority for producers. This presents a challenge for cotton breeders to improve fibre quality while maintaining yield in order to keep cotton a competitive product. In order to achieve this, a study was conducted to determine the use of fibre density (FD), (fibres per seed divided by seed surface area) in decreasing fineness while maintaining yield. 1. A preliminary study was conducted to determine the diversity of FD within the CSIRO collection. 2. Breeding lines with high and low FD were chosen to create populations with varying FD to enhance variability and create new germplasm. 3. The utility of FD in breeding was tested by crossing lines with high or low FD with two high micronaire genotypes, creating a total of four populations. The results indicate an improved frequency of progeny with desirable finer or lower micronaire in populations from high FD and high micronaire parents compared with populations from low FD. This study has also generated a new breeding line which has competitive yield and high FD to be used as an elite parent. These results indicate FD could be a useful breeding tool in maintaining yield while improving fibre fineness.

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Fruit retention and distribution in Bollgard III, Bollgard II and Conventional cotton crops across the Australian cotton growing regions

Meredith Conaty

Monsanto Australia

Stream: *Agronomy and Soils* **Oral**

Bollgard III is a new transgenic product developed by Monsanto Company, containing three Bt toxins (Cry 1Ac, Cry 2Ab and Vip 3A) for the in-crop control of *Helicoverpa sp*. in cotton. Since these genes prevent damage to developing fruit, the number of fruit retained by Bollgard crops, and their distribution has been shown to be significantly different from conventional cotton grown without insect control. The fruit retention, distribution and yield of Bollgard III, Bollgard II and Conventional (not insect protected) cotton plants were measured at six sites in 2011-12 and two sites in 2012-13 throughout the Australian cotton growing region in the Eastern states and Northern Australia. No insect control was applied to any of the crops, all other management was representative of commercial practices. The total number of fruiting positions and the total number of bolls was measured at the end of the season, two days prior to harvest. There was no difference in the total fruit retention, the first position fruit retention or the distribution of bolls in the canopy between the Bollgard II and Bollgard III plants. Both Bollgard II and Bollgard III crops showed a higher first position fruit retention, and maintained a greater proportion of fruit lower in the canopy than the conventional plants. This data is the first measurements taken in Australia describing the growth and development of Bollgard III plants, and defines the scale of the increase in retention and the changes in plant morphology resulting from the protection of squares and small bolls from insect pests.

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Where do boll nutrients come from? The contribution of individual leaves to the Nitrogen and Potassium in a mature boll.

Meredith Conaty[1] and Ian Rochester[2]

[1]Monsanto Australia (work carried out while at University of Sydney), [2]CSIRO Plant Industry

Stream: *Agronomy and Soils* **Oral**

It is generally assumed that the main source of N, K and other nutrients in a developing boll is the subtending or adjacent leaf on the sympodial branch. This assumption is often based on circumstantial evidence linking the changes in concentration in adjacent tissues, rather than quantitative studies examining single leaves and bolls. To quantify the contribution of leaf nutrients to a single boll, 15N and Rb were applied directly to mainstem and 1st position leaves. These acted as tracers to measure the redistribution of N and K from individual leaves and to trace their movement through the rest of the plant. The accumulation of N and K in each tissue along a single sympodial branch was also described through sequential tissue sampling of branches tagged at flowering every 5 days. The distribution patterns of remobilised N and K from the mainstem and 1st position leaves were different, and both N and K were transported throughout the whole plant. The relative contribution of the mainstem leaf to the 1st position seed was around 5% of the total N and none of the K, while the 1st position sympodial leaf supplied almost 7% of the seed N and 2% of the K. Contributions to the boll wall, second position leaf and leaves and fruit throughout the canopy were also calculated. These results show that the subtending leaf is not the major source of boll N and K. It was hypothesised that the remainder of the seed N and K was supplied from remote sites or root uptake.

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Rapid field-based phenotyping for breeding water-use efficient cotton

Warren C. Conaty, Greg A. Constable and Alan Thompson

CSIRO Plant Industry

Stream: *Breeding* **Oral**

Water stress is the most significant limitation in Australian cotton production, where historically cotton yields have reflected irrigation water and rainfall availability. While gains in crop level water-use efficiency have been achieved through improved management practices and breeding cultivars with increased yield, physiological gains in water-use efficiency have been limited. Biotechnology approaches to engineering improved water-use efficiency in cotton is yet to produce any significant outcomes, and results are probably >10 years away. No suitable field-based screening methods for rapidly resolving differences in water-use efficiency or water stress tolerance in breeding material have been successfully used. Our studies show that by combining crop yield and plant mapping with photosynthesis, stomatal conductance, chlorophyll fluorescence and canopy temperature data, differences in physiological water-use efficiency between genotypes can be determined. This information can then be used to develop, test and implement a procedure for screening breeding material for water-use efficiency or water stress tolerance, with a particular focus on canopy temperature. This paper presents the background research used to identify canopy temperature as a potential rapid-screening tool for water-use efficiency. This includes the associations between canopy temperature and yield, stomatal conductance and water-use efficiency. Measurements of water-stress physiology (gas exchange, chlorophyll fluorescence, canopy temperature, yield and fibre quality) have been conducted to determine the conditions (water deficit, physiological stage, time of day etc) required to successfully measure and resolve genotypic differences in canopy temperatures and how these translate to water stress tolerance and water-use efficiency. Future work will focus on a canopy temperature-based field phenotyping platform for evaluating water stress in early generation breeding populations. A prototype ground-rig equipped with infra-red thermometer sensors has been developed for measuring up to 3000 plots h^{-1} and will undergo testing in the 2013-14 season.

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Water-use efficiency in irrigated cotton production

Warren C. Conaty and Greg A. Constable

CSIRO Plant Industry

Stream: *Agronomy and Soils* **Oral**

Cotton production is affected by water supply. The risk associated with inefficient irrigation management, through over or under supply of water, is that plants will be unable to efficiently partition carbon into harvestable yield, resulting in potential yield reductions. The relationship between water application and cotton yield can be described as a function where yield increases with water and then diminishes at a certain level of applied water. Thus, the irrigation regime that produces a peak in crop yield may not necessarily also produce a peak in water-use efficiency. Recent studies have shown that the water-use efficiency of irrigated cotton production in Australia has been increasing. This increase may be due to irrigation application efficiency, but increased yield potential in new cultivars may mask the effect of irrigation efficiency. It has nominally been observed that the duration between furrow irrigation events in some high-input irrigated cotton production systems have been decreasing. This practice may have developed due to the wide-spread belief that increased application of irrigation water results in higher crop yield. However this may be at the expense of reduced water-use efficiency, so the challenge for modern irrigation scheduling is to find the optimum water application regime and determine the volume and frequency of water required. This paper presents data that highlights that peaks in the associations between yield and water-use efficiency do not necessarily correspond to the same level of water application. We conclude that the trade-off between peak yield and water-use efficiency needs to be considered in conjunction with irrigation water costs and availability when scheduling irrigations.

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Heat tolerance of cotton

Nicola Cottee, Michael Bange and Iain Wilson

CSIRO Plant Industry

Stream: *Breeding* **Oral**

High temperatures (>35°C) are common throughout the cotton growing season in many regions and may adversely affect the growth and development potential of the crop, ultimately limiting yield. Development of cotton plants with increased stress resistance may help buffer yield losses due to increased heat load and limited water availability associated with predicted climate models. Development of stress screening techniques will enable selection of heat tolerant genotypes for incorporation into future breeding programs. This study evaluated the utility of rapid and field based physiological screens for resolving differences between cotton genotypes for heat tolerance. Genotypes were evaluated under warm and hot environments using in-situ measurements of chlorophyll fluorescence and leaf temperature as well as an enzyme viability laboratory assay. Genotypes with higher heat tolerance generally performed better for chlorophyll fluorescence. However, ambient air temperatures preceding the measurement period greatly affected ability to resolve between cultivars for heat tolerance and physiological performance. Results of this research will contribute to a larger study which aims to determine the underlying mechanisms of abiotic stress resistance, including interactions between drought and heat stress. This new understanding of heat and drought interactions will be used to develop an abiotic stress index for cotton which may aid in the selection of cultivars for improved drought and heat tolerance, contributing to the development of stress resistant cropping systems.

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Effects of cotton cellulose structure and fibre surface substrate interactions on dye uptake

Genevieve Crowle

CSIRO Deakin University

Stream: *Post Harvest* **Oral**

Dyeing of cotton is influenced by a range of chemical and physical interactions between dye molecules and fibres, many of which are not well understood. In this paper the cotton fibre properties that affect dye uptake, such as maturity and fineness are reviewed in light of dye uptake problems that occur for cotton that is nominally the same in terms of HVI properties. Investigations of cotton's fibre surface chemistry and cellulosic structure are proposed to assess and explain the interaction between dye uptake and fibre properties.

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Chasing the glass transition of cotton

Chantal Denham[*#], Mickey Huson[*] , Stewart Gordon[*] and Xungai Wang[#]

CSIRO[*] Deakin University[#]

Stream: *Post Harvest* **Oral**

The glass transition temperature is a thermal transition at which point a polymer goes from a firm glassy state to a more soft pliable form. It is hypothesised that the glass transition temperature of cotton and its dependence on moisture, are key factors in judging the best temperature and humidity in which to process cotton. Differential scanning calorimetry is a method often used to measure the temperature of this transition in synthetic polymers, however cotton and other cellulose products demonstrate weaker transition signals, predominantly due to the highly crystalline nature of the material. The current work aims to find a reproducible set of conditions under which the glass transition temperature may be isolated and measured in cellulose. As part of this work, sample densities will be used to rank the order of samples by crystalline content.

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Is soil nutrientt supply at breaking point with recent high yields

Chris Dowling

Back Paddock Company

Stream: *Agronomy and Soils* **Oral**

With recent increase in cotton yields related to significant change is cotton varieties, soil and water management, many questions are being asked across the industry about the adequacy of soil nutrient supply to meet the new short and long term nutrient demand. While soil testing is a regular assessment tool for nutrient supply in cotton, its ability to responsiveness predict in current crops may be limited by the age and quantity of calibration data. A study to assess the nutrient adequacy of the 2012 and 2013 cotton crops was conducted using the results of 770 commercial plant tissue analyses from the Macquarie, Namoi, Gwydir, Macintyre and Darling Downs and relating them to established plant tissue critical levels. In general the nutrient trends with crop age reflected those suggested in the literature however some differences were noted. The nutrients for which there were significant numbers of samples below the critical level included nitrogen> potassium> phosphorus> zinc. Sporadic incidence of low copper and boron were also measured. Moderate to high concentration of sodium was measured in a large number of samples. For some nutrients current critical levels in Nutrilogic reflected typical levels rather than critical levels giving the impression that nutrients other than those traditionally managed may be affection yield.

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AusAgLCI - the business case for investment in national life cycle inventory for cotton

Sandra Eady and Helen Cruypenninck

CSIRO Life Cycle Strategies

Stream: *NRM* **Oral**

Over the last decade there has been a significant focus on the environmental impact of products and services across the economy, resulting in environmental product declarations and delivery agreements where the supplier is required to demonstrate an on-going improvement program of environmental sustainability. Once action is required (as imposed by a supplier or a pricing mechanism) primary producers need to be able to make an objective assessment of their environmental impact (by Life Cycle Assessment) so that "hot spots" in their production system can be identified, and options to reduce these impacts can be investigated. Country specific Life Cycle Inventory (LCI) for agricultural products is essential for Australian agriculture to undertake environmental impact studies related to food and fibre, especially where differences in management systems and regional climate, soils and vegetation significantly affect LCA results. The goal of inventory collection for AusAgLCI is to provide underlying data to ensure Australian primary producers can readily, and objectively, demonstrate that their products are being produced in a responsible manner, in a system where environmental assessment is used to aid and drive improvements. This will assist producers to meet marketing requirements and to benchmark their production in global markets. This paper will explore the relevance for cotton producers and present some inventory results for Australian cotton compared to global cotton production.

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The analysis of host-plant origin using the triacylglycerol content of *Helicoverpa armigera*

Ben W. Greatrex, Peter C. Gregg, Alice del Socorro, Mujibur Bhuiyan and Robert Murison

The University of New England

Stream: *Pest Management* **Oral**

The transgenic Bt cotton Bollgard II expresses insecticidal proteins that reduce the requirement for spraying to control lepidopteran insect pests such as *Helicoverpa armigera* and *H. punctigera*. Resistance in the insects is a potential problem and in Australia, refuge crops are used to dilute the resistance alleles by providing a non-selective larval food source. Structured refuges are pigeon peas or conventional cotton, but any non-Bt crop (such as soybeans) planted in the vicinity of the Bt cotton might produce a similar effect. To assess the contributions of both structured and unstructured refuges to moth populations we have developed an assay to identify the larval host plant for the adult moth by quantifying diacylglycerols and triacylglycerols by HPLC-APCIMS. There were 39 different triacylglycerols identified in moths reared as larvae on cotton, pigeon pea and soybean. Discriminant analysis was used to analyse the ratios of triacylglycerols and identify the minimum number of triacylglycerols that could be used to identify the host plant. The model developed used 5 triacylglycerols to discriminate moths reared on the three plants and could correctly identify the larval host of a test set of moths.

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Can sustainable biological disease suppression be achieved in cotton farming systems?

Gupta, V.V.S.R.[1], Linda Smith[2] and Karen Kirkby[3]

[1]CSIRO Ecosystem Sciences, [2]DAFF, [3]NSW DPI

Stream: *Pest Management* **Oral**

Disease suppression is the 'ability of a soil to suppress disease incidence or severity even in the presence of the pathogen, host plant and favourable environmental conditions'. Enhanced biological disease suppression has been shown in broadacre crops (Gupta et al. 2011) and suggested to be present in cotton soils, e.g. biological disease suppression of black root rot. Evidence from rainfed grain cropping systems suggests the involvement of a diverse group of bacteria, fungi and protozoa for effective and continued suppression. Fungi are an important component of soil biota with capacity to affect pathogen inoculum levels and their disease causing potential. Crop rotation history and stubble management can significantly influence fungal diversity in cotton soils. Soilborne diseases such as Fusarium wilt, Black root rot and Verticillium wilt have significant impact on cotton production. Currently the management of disease impacts is through the selection of genetically resistant cultivars (where available), agrochemical application and rotation with non-host crops. But even in our current high F-rank cultivars significant losses can occur from Fusarium disease under the right environmental conditions. Crop rotation, stubble retention and tillage can either reduce the levels of pathogen inoculum and/or modify pathogen-soil microbe interactions thereby influencing disease impacts e.g. lower Fusarium wilt incidence following sorghum and maize. New DNA based techniques can assist with understanding the diversity and activities of soil microbial communities in cotton soils. Improving soil based biological suppression would augment our efforts to reliably reduce disease impacts on cotton yield.

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Crop rotation influences microbial activity, diversity and nitrogen mineralization in cotton soils

Gupta, V.V.S.R.[1] and Ian. Rochester[2]

[1]CSIRO Ecosystem Sciences, [2]CSIRO Plant Industry

Stream: *Agronomy and Soils* **Oral**

Crop rotation in cotton farming systems is practiced for disease break and weed control, and where legumes are used for increased N supply. It provides options to better manage soil biological functions by modifying populations and activities of beneficial and pathogenic microorganisms. Varying quality and quantity of crop residues from alternate crops can affect populations and biological activities related to carbon turnover, N and P supply and disease suppression. To achieve greater crop N use efficiency in high yielding irrigated cotton it is necessary to consider the N mineralization potential (Nmin) which is dependent upon the inherent soil fertility and biological activity. We measured microbial activity, catabolic diversity, microbial biomass (MB) and Nmin in surface soils prior to sowing of cotton in the cropping systems experiment in Field 6 at the ACRI. Soils from oats-vetch-cotton (OVC) rotation supported highest level of MB and activity followed by cotton-vetch-cotton (CVC) rotation, whereas the oats-fallow-cotton (OFC) rotation contained lowest level of all the microbial properties measured. Soil from the OVC rotation contained more N in the MB (34 kg/ha than the OFC) and exhibited highest level of Nmin (71% more than the OFC). Overall, the addition of larger amount and a more diverse quality carbon inputs (stubble and rhizodeposition) in the OVC rotation resulted in a more active and diverse microbial community and the rotation with fallow exhibited lowest catabolic diversity of soil microbial community. The greater microbial activity in the OVC rotation system was related to improved lint yield in this system.

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The effects of aphids on photosynthesis in cotton

Simone C. Heimoana[1] Lewis J. Wilson[1] Doug L. George[2] Greg A. Constable[1]

[1]CSIRO Plant Industry, [2]The University of Queensland

Stream: *Pest Management* **Oral**

Aphids can affect photosynthesis and other leaf gas exchange parameters in cotton with consequent effects on yield and productivity, yet the extent of the effects is not well known. We monitored effects on cotton leaf photosynthesis as aphid populations built through the growing season. In two of six experiments aphid feeding significantly reduced the photosynthetic rate of infested leaves. In these experiments increasing aphid density progressively and negatively affected photosynthesis and other gas exchange parameters. Aphid damaged leaves were hotter, reflecting reduced transpiration. Maximum reduction in photosynthesis of 27% occurred at a density of 27.6 aphids/cm^2 . Comparing effects on components of gas exchange, a 10% decline in photosynthesis occurred at 12.9 aphids/cm^2 while a similar decline in stomatal conductance occurred at 7.7 aphids/cm^2 . At aphid densities of $<$ 5 aphids/cm^2 responses were less consistent. In two experiments with aphid populations of 0.7 - 1.5 aphids/cm^2 significant negative effects on photosynthesis and stomatal conductance occurred within 8 days of infestation. Leaves did not exhibit tolerance of aphid feeding as regression analyses showed a direct linear decline of photosynthesis and conductance in response to increasing populations. Removal of aphids, once leaf photosynthesis had declined significantly, did not lead to recovery of leaves indicating that aphid feeding damage was permanent. Closure of stomata was implicated as a cause of reduced photosynthesis as aphid infested leaves were found to have a higher proportion of closed stomata than non-infested leaves. The intensity and duration of aphid infestations affected the extent of damage to leaves and their photosynthetic responses.

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The population genomics of glyphosate resistance weeds

James Hereward

The University of Queensland

Stream: *Pest Management* **Oral**

Resistance to glyphosate poses a growing risk to agricultural sustainability, with at least 24 resistant weed species reported to date. There are up to 11 known "non-target site" resistance mechanisms to glyphosate but the genetics underpinning these mechanisms is unknown. Further, weeds that have become resistant to multiple modes of action are concentrated in three genera (Amaranthus, Conyza, Echinochloa), and it is not clear why some groups of weeds are so effective at attaining resistance. I will discuss the application of new sequencing technology and analytical approaches to these two problems. Specifically I will discuss the use genomics approaches to detect signatures of selection in wild populations as a means to uncover the genetic basis of resistance mechanisms, the application of transcriptomics to explore non-target site mechanisms, and genomic approaches to assessing the role of genetic diversity in weeds that are able to evolve multiple mode of action resistance.

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Soil quality and energy use in irrigated cotton-based cropping systems

N. R. Hulugalle[1], T. B. Weaver[1,2], L. A. Finlay[1] and V. Heimoana[1]

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Stream: *Agronomy and Soils* **Oral**

Comparative studies of soil quality and energy use in two- and three-crop rotations in irrigated cotton-based cropping systems under varying stubble management practice in Australian Vertosols are sparse. Our objectives were firstly, to quantify selected soil quality indices, crop yields, and greenhouse gas emissions in four irrigated cotton-based cropping systems sown on permanent beds in a Vertosol, and secondly, to evaluate the efficacy of sowing vetch in rotation with cotton on black root-rot incidence in cotton seedlings. The experimental treatments were: cotton-cotton, cotton-vetch, cotton-wheat where wheat stubble was incorporated, and cotton-wheat-vetch where wheat stubble was retained as in-situ mulch. Vetch was terminated during or just prior to flowering by a combination of mowing and contact herbicides, and the residues retained as in situ mulch. Compared with cotton monoculture, including wheat as a rotation crop improved cotton yield, and reduced soil quality decline, emissions of carbon dioxide equivalents (CO_2-e)/area and CO_2-e emissions /kg cotton lint. Including vetch in the rotation was of negligible benefit in terms of yield and emissions. Soil quality was best with cotton-wheat and cotton-wheat-vetch but poorest with cotton-vetch. CO_2-e emissions associated with growing a hectare of cotton could be reduced by growing vetch because of substituting fixed atmospheric N for N fertiliser derived from fossil fuels, but this advantage was partly negated by the emissions from farming operations associated with growing a vetch crop.. Incidence of black root-rot increased as the number of cotton crops sown increased.

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Scanning probe microscopy – More than just a pretty picture

Mickey Huson

CSIRO Materials Science and Engineering

Stream: *Post Harvest* **Oral**

The scanning probe microscope is a versatile tool which, at its simplest, records images of samples by scanning a fine mechanical probe, attached to a cantilever, across the surface, "feeling" the topography. The probe can be in continuous contact with the surface or may oscillate at high frequency as in the so-called tapping mode. If the probe is moved at 90º to its normal fast scan direction then torque is imposed on the cantilever and an image can be recorded based on the friction between the probe and the sample. All these images can be acquired in air (ambient or controlled) or a liquid environment, and at room or elevated temperature. If, instead of scanning the surface, the probe is pushed into contact with the surface and then withdrawn, a force curve is recorded. This can be analysed to yield information about the nano-mechanical properties (stiffness, adhesion, resilience and visco-elasticity) of a material's surface. Collecting a matrix of force curves can yield an image based on some physical property such as adhesion. In some instances single protein molecules are pulled off the sample surface in molecular pulling experiments. Worm-like chain model analysis then yields information about chain unfolding. This presentation will provide an overview of scanning probe microscopy and use a range of examples on samples such as resilin, wool, gelatine and cotton to illustrate the capability and versatility of the instrument.

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Enhancing cotton crop simulation modelling to meet future research needs

David Johnston, and Michael Bange

CSIRO Plant Industry

Stream: *Agronomy and Soils* **Oral**

The Australian cotton simulation model OZCOT originally developed by Brian Hearn has served the industry for many years. Recently OZCOT has been re-engineered using the CSIRO common modelling protocol which allows it to be used in both the APSIM and AusFARM modelling systems. In doing this the model can now access specialised and more advanced simulation components, like soil water, soil nitrogen and reporting. Crop modelling continues to be a critical tool in many research efforts. Current initiatives include long term simulations of viability for new cotton regions in the far north and the south, fibre quality modelling, irrigation strategy analysis, cultivar evaluation management strategies, to soil compaction under harvest traffic. Questions of climate change and its potential effects on cotton production also critically rely on effective and reliable modelling tools and OZCOT will play an important role. These new areas of research are continuing to prove the value of the cotton model, but are also pushing the tested limits of the science and are highlighting areas that need further research and model development. This presentation updates the progress being made in these areas of cotton simulation science using OZCOT.

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Emergence of four weed species in response to rainfall and temperature

Michelle D. Keenan and Jeff Werth

Department of Agriculture, Fisheries and Forestry, Queensland

Stream: *Pest Management* **Oral**

Fleabane, sowthistle, awnless barnyard grass and feathertop Rhodes grass are becoming widespread in cropping areas of the northern region due in part to over-reliance on glyphosate. These species are most effectively controlled while young. Therefore, an understanding of emergence patterns and triggers is important for their timely management. Rainfall treatments were applied in one application in the first experiment and incrementally over one to six days in the second experiment. Germinations occurred at two temperature regimes (30°C/20°C day/night and 25°C/15°C day/night) with a 12 hr photoperiod. Rainfall amount and species were significant in relation to seedling emergence while the effect of temperature was not significant for both experiments. Emergences of feathertop Rhodes grass and awnless barnyard grass were consistently greater across the majority of rainfall treatments regardless of application or temperature. With the exception of one feathertop Rhodes grass seedling, no species emerged with less than 10 mm rainfall. At 30°C/20°C feathertop Rhodes grass emerged 2 days after treatment (DAT) while the remaining three species emerged at 3-4 DAT in both experiments. At 25°C/15°C feathertop Rhodes grass and sowthistle emerged 3 DAT after a single rainfall application but with incremental rainfall, feathertop Rhodes grass emerged 2 DAT and sowthistle 4 DAT. The remaining species emerged at 4 DAT in both experiments. This study has provided useful information on the interaction between temperature and rainfall in relation to the emergence of these species, and will assist in making timely weed management decisions.

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Understanding Soelnopsis mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) damage and within plant distribution on Bollgard® cotton

Moazzem Khan, Kristy Byers and Gail Spargo

Department of Agriculture, Fisheries and Forestry, Queensland

Stream: *Pest Management* **Oral**

Solenopsis mealybug, *Phenacoccus solenopsis* Tinsley is an emerging pest of cotton in Australia with the first outbreaks occurring in Emerald and in the Burdekin during the 2009-10 season. Overseas literature indicates that mealybug can cause significant damage to cotton. In Australia, detailed information about mealybug damage and its distribution on cotton plants is limited. We conducted several field and glasshouse trials, to gain an understanding of mealybug damage in relation to its lifecycle and crop stage as well as its distribution within plants at different crop stages. Trial results indicate that the most damage to cotton is caused by adult mealybug followed by large nymphs. Mealybug infestations on 4 – 5 leaf, squaring and early boll stages led to a significantly lower number of bolls and lower yields than mealybug infesting more mature crop stages. Observations at the cut-out stage showed that crops with high mealybug damage had up to an 80% reduction of harvestable bolls on the top eight nodes. The distribution of mealybug on cotton plants from seedling to early boll stage showed 70% of mealybug on the underside of leaves and inside bracts of squares and bolls, on the top two third of the plants. At late boll stage mealybug was equally distributed throughout the plant. The implications of these findings in terms of management of mealybug in cotton are to be discussed.

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Three decades of cotton disease surveys in NSW, Australia

Karen A. Kirkby[1] Peter A. Lonergan[1] Stephen J. Allen[2]

[1]NSW DPI [2]Cotton Seed Distributors

Stream: *Pest Management* **Oral**

Three decades of disease survey data have shown Verticillium wilt was one of the first major diseases of cotton recorded in 1984/85 season. Survey reports the mean incidence was 4.1% in 1984/85 season and rose to 16.6% in 1989/90 season. Prior to 1984 all commercial varieties of cotton available in Australia were susceptible to bacterial blight and the disease was common. The adoption of the resistant varieties contributed to a dramatic decline in the incidence of bacterial blight and the removal of bacterial blight as a significant pathogen to Australian cotton crops by 1992. Survey results showed the incidence of black root rot increased on farms with a long history of growing cotton during the 1990's. Fusarium wilt of cotton was first reported in NSW in 1994. The disease is now widespread, being confirmed on 86 NSW farms in six of the eight cotton production areas in NSW. These four significant plant disease 'problems' have challenged the cotton industry in New South Wales (NSW). Data provided by the surveys have indicated the relative importance of each of the diseases present and the impact of cultural practices and the adoption of new varieties on disease distribution, incidence and severity. The results have therefore been used to support and justify requests for research funding and have contributed to the development of Integrated Disease Management strategies. NSW DPI continues to monitor the distribution of disease and the incidence and severity present in commercial cotton crops in all production areas of NSW. The aim of this paper is to highlight four significant cotton diseases in Australia and show relationships between cultural practices and declining and increasing incidence of disease.

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Assessment of the efficacy of insect protected Bollgard® III x Roundup Ready Flex® cotton against *Helicoverpa spp*. across Australian cotton growing regions

Kristen Knight

Monsanto Australia

Stream: *Pest Management* **Oral**

Nine trial sites were conducted over the 2010 - 12 Australian cotton seasons to determine the efficacy of the transgenic cotton Bollgard® III Ã— Roundup Ready Flex® which contains the insect resistant genes cry1Ac, cry2Ab and vip3A. The field trials assessed damage in terminals, squares and small bolls as well as measuring *Helicoverpa spp.* abundance across the treatments including; Bollgard® III, Bollgard® II and non–Bt Roundup Ready Flex®. Leaf samples were collected from the sites and bioassays with *Helicoverpa spp.* were set up to check for mortality and the number of surviving larvae along with development stage and weights of the surviving larvae. The data from these trials demonstrates that the addition of the vip3A gene contributes to overall efficacy of the plant in controlling *Helicoverpa armigera* and *H. punctigera*.

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On line cotton contamination sensors for Australian gins

Andrew Krajewski, Stuart Gordon, Andrew Tulloh, David Fox, Neale Gibbons and Scott Barnes

CSIRO Materials Science and Engineering

Stream: *Post Harvest* **Oral**

Australian cotton has low levels of contamination and as such is able to command premiums on the basis of this property. There is an imperative to maintain this impression in the market. This paper presents a solution to a current problem involving contamination from the yellow plastic used to wrap round modules from the John Deere 7760 Harvester. The paper presents design of a sensor for the gin module hood that automatically detects and alerts gin operators to the presence of the yellow plastic and other fibrous materials caught on the module beaters. The paper describes the system, which has been implemented in a number of Australian gins since the 2012 ginning season. The method and data presented in this paper shows how the system successfully captures contamination events, allowing ginners to react promptly to remove contaminants before they are fragmented and allowed to enter the ginning process.

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The Ecology of *H. punctigera*: overwintering in local fields and Inland Queensland?

Kris Le Mottee, Peter Gregg and Alice Del Socorro

University of New England

Stream: *Pest Management* **Oral**

The discovery of Bt resistance genes in populations of *H. punctigera* has led to the re-evaluation of their overwintering behaviour and diapause onset conditions. Preliminary results of lab experiments exposing *H. punctigera* larvae to different temperature and photoperiods suggest that the conditions for the onset of diapause remain largely unchanged. Experiments at Boggabri, NSW suggest very high levels of mortality in *H. punctigera* larvae when feeding on the key refuge crop pigeon pea (*Cajanus cajan*). High larval mortality on pigeon pea, provides a barrier to local experiments and suggests a very low overwintering population at these sites, even when populations persist late into the Autumn season. Emergence cage experiments in inland Queensland show that *H. punctigera* overwinters in the region, but diapause is not induced by these winter conditions. Larval surveys in this area show when host plants are present, larvae are present in large numbers on both floodplains and sand dunes. A GIS model of *H. punctigera* aims to combine the pre-drought (1987-2000) and post-drought (2009-2013) insect survey data with vegetation survey maps and climate data, in order to predict future *H. punctigera* populations.

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Breeding progress and challenge for better quality cotton grown in high yielding production system

S. M. Liu, G. A. Constable, W. N. Stiller and P.E. Reid

CSIRO Plant Industry

Stream: *Breeding* **Oral**

Good fibre quality offers better on-farm return in high yielding cotton production system. Fibre quality is described by grade, length, uniformity, strength and micronaire and some of these properties, such as fibre length and strength, are known to be negatively associated with lint yield due to gene repulsive linkage and/ or pleiotrophic effects. Based on a retrospective analysis of long term regional data of CSIRO bred conventional cotton (*Gossypium hirsutum*), this presentation describes an improved trend of lint yield and key fibre properties and also their associations over a recent 15 year period. Recently developed cotton possessed higher yield and better fibre quality; however, adverse associations still existed for yield with fibre strength and fineness. Although cotton yield and fibre quality were simultaneously improved in the past, the ongoing challenge remains for developing high yielding cotton with better (premium) fibre quality.

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Development of mutagenised populations for the genetic dissection of important agronomic traits in cotton

Shiming Liu[1)], Linda Tabe[3)], Filomena Pettolino[2)] Danny Llewellyn[2)], Liz Dennis[2)] , Greg Constable[1)], and Warwick Stiller[1)]

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Stream: *Breeding* **Oral**

Induced mutations have long been used to generate additional genetic diversity and/or novel traits of agronomic interest in cotton breeding and genetic research. When cotton seeds are exposed to radiation or chemicals mutagens, its genomic DNA is randomly altered by either change of single nucleotides and/or the removal of a few to hundreds of nucleotides. If these structural changes escape repair or are repaired incorrectly, they will be passed to offspring and may express as mutated phenotype such as increased variability of agronomic traits (e.g. boll size, fibre length, earliness) or novel discrete characteristics (e.g. dwarf stature or seeds with short fibre). Genetic studies on such material will provide a better understanding of gene function and genomic location, which are essential for the isolation, cloning and manipulation of specific genes to improve cotton performance. In last five years, a number of mutagenised populations of diploid and tetraploid cotton were created when seeds were treated by either heavy ion bombardment (HIB) or chemical mutagens (i.e. ethyl methane sulphonate (EMS) and Sodium Azide). Field screening was applied each year to identify mutations in quantitative and qualitative traits with potential agronomic value. Despite a low frequency of discrete mutations, there was a large variation exhibited among mutated lines for yield, maturity, fibre properties and disease resistance that are being further investigated. Some mutants possessed unique characteristics for plant height, leaf colour and fibre development. Inheritance studies on one short fibre and another immature fibre mutant from the EMS mutagenised diploid population demonstrated that both of them were due to single recessive genes. It is clear that mutation breeding can offer novel genetic sources for future research on cotton physiology, fibre formation and disease resistance.

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Pectin methylesterase and pectin remodelling differ in the fibre walls of two Gossypium species with very different fibre properties.

Qinxiang Liu, Mark Talbot, and Danny J. Llewellyn

CSIRO Plant Industry

Stream: *NRM* **Oral**

Pectin methylesterase and pectin remodelling differ in the fibre walls of two Gossypium species with very different fibre properties. Qinxiang Liu, Mark Talbot, and Danny J. Llewellyn* Abstract Pectin, a major component of the primary cell walls of dicot plants, is synthesized in Golgi, secreted into the wall as methylesters and subsequently de-esterified by pectin methylesterase (PME). Pectin remodelling by PMEs is known to be important in regulating cell expansion in plants. We determined fibre PME transcript abundance, total PME activity, pectin content and extent of de-methylesterification in fibre walls of two cotton species. There was a higher transcript abundance of fibre-PMEs and a higher total PME enzyme activity in *G. barbadense* (Gb) than in G. hirsutum (Gh) fibres, particularly during late elongation. Total pectin was high, but de-esterified pectin was low during fibre elongation (5-12dpa) in both Gh and Gb. De-esterified pectin levels rose thereafter when total PME activity increased and this occurred earlier in Gb fibres resulting in a lower degree of esterification in Gb fibres between 17 and 22 dpa. Gb fibres are finer and longer than those of Gh, so differences in pectin remodelling during the transition to wall thickening may be important in influencing final fibre diameter and length, two key quality attributes of cotton fibres.

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Future Biotechnologies

Danny Llewellyn

CSIRO Plant Industry

Stream: *Breeding* **Oral**

GM traits such as Bollgard® II and Roundup Ready Flex® have made large impacts on cotton production in Australia over the last seventeen years. They have contributed positively towards better and environmentally sustainable insect and weed control and have added to the ease of production and profitability of cotton for both growers and regional areas. In the short to medium term, new technologies in the pipeline of major trait providers include more of the same (such as for example Bollgard® III), but perhaps from different technology providers, or at least in different stacked combinations, to address concerns (and in some cases the realities) of target pests or weeds becoming resistant and hence poorly controlled. This may provide some diversification in the global market place. A number of the promised new traits of ten years ago have not yet been delivered, either because of inconsistent performance or an inability to capture value back from their high development or commercial registration. The costs of GM registration have not fallen even after widespread adoption of GM technologies in global agriculture over the past 20 years. In the longer term the focus of many research groups is to improve understanding of plant developmental or agronomic processes using new genomic approaches that will help identify specific genes controlling plants. Once identified, these genes could be manipulated using either GM plants or modern molecular breeding technologies to improve crop performance. Some of the novel traits and technologies being developed around the World for use in cotton or other agricultural crops will be reviewed.

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An assessment of alternative cotton fiber qualtiy attributes and their influence on yarn strength

Robert L. Long1, Michael P. Bange[2], Christopher D. Delhom[3], Jeffrey S. Church[4], Greg A. Constable[2]

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Stream: *Post Harvest* **Oral**

Knowing the yarn strength performance potential of cotton fiber is advantageous to spinners during mill preparation, and to researchers developing new genotypes and management strategies to produce better fiber. Both micronaire, which is a collective measure of fiber fineness and maturity, and bundle tensile properties, are important standard High Volume Instrument (HVI) fiber quality attributes. Two field experiments over two seasons were conducted to assess the fiber and yarn performance of Australian cotton genotypes. The aim was to assess and compare alternative measures for micronaire, and to compare bundle and single fiber tensile measurements, and assess the relative yarn strength predictive performance of these attributes. Specific fiber measurement comparisons were for linear density [double compression Fineness Maturity Tester (FMT) and gravimetric), maturity ratio (FMT, polarized light, calculated and cross sectional), and tensile properties (HVI bundle and Favimat Robot single fiber). Multiple linear regression models for yarn strength which included yarn manufacturing variables and standard HVI fiber quality parameters performed well but models performed better when alternatives to micronaire were used; e.g. using gravimetric linear density or using laser photometric determined ribbon width. Yarn strength models were also better when single fiber tensile properties were substituted for bundle tensile properties. The substitution of alternative fineness variables for micronaire or single fiber strength for bundle strength in a simple fiber quality index also improved the prediction of yarn strength.

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Irrigated cotton crop phenology in a new temperature regime

Qunying Luo

University of Technology, Sydney

Stream: *Agronomy and Soils* **Oral**

The daily outputs of CSIRO Conformal Cubic Atmospheric Model driven by four general circulation models (GCMs) were used by a stochastic weather generator: LARS-WG to construct local climate change scenarios (CCSs) at nine key cotton production areas in eastern Australia. These CCSs were then linked to daily temperature driven models of cotton phenology to examine the effects of increased temperature on the initiation and duration of key crop phenophases. Results show that when using 1 Oct. sowing the timing of (1) emergence, 1st square (flower bud), 1st flower and 1st open boll advanced 1~9, 4~13, 5~14, 8~16 days respectively for the period centred on 2030 compared to the period centred on 1990; (2) when crops planted 10 days earlier, emergence advanced more in most of the locations while other phenological events changed only slightly (approximately 1 day) in comparison with 1st. Oct. sowing; when crops planted 10 days later all these events generally were delayed (approximately 1.5 days) depending on locations in comparison with 1st Oct. sowing; (3) the timing of last effective square, the last effective flower and the last harvestable boll were delayed 7~12, 6~9 and 3~9 days respectively across locations and GCMs; (4) combining the effects of an earlier time of first square and a later last effective square potentially increases the time for new fruit (squares) to be produced by up to two to three weeks. This analysis highlights the challenges associated with temperature with future climate change for future cotton production in Australia.

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Molecular regulation of secondary cell wall deposition in cotton fibres

Colleen MacMillan, Liz Brill, Liz Dennis, and Danny Llewellyn

CSIRO Plant Industry

Stream: *Breeding* **Oral**

Cotton fibres are long thin cells of the seedcoat that develop a very thick secondary cell wall (SCW) composed of almost pure cellulose that constitutes the bulk of the fibre mass. High rates of cellulose deposition within the fibre begin about 16-18 days after flower opening and continue for another 20 or more days. The SCW determines many fibre quality properties like fibre strength, elongation and maturity and the onset of SCW deposition may also terminate fibre elongation and hence affect fibre length. We are interested in how this SCW deposition is regulated at the molecular level. NACs (No apical meristem NAM, ATAF, CUC cup shaped cotyledon) are transcription factors that regulate many processes in the plant life cycle and some NACs are known to regulate the activation of secondary cell wall production in Arabidopsis, poplar, Medicago, rice, and maize stems so are good candidates for regulating fibre SCW deposition. We describe the identification of several NACs of Upland cotton, *Gossypium hirsutum*, that on the basis of their expression patterns are likely to be SCW regulators. Promoter sequences of these NACs have been determined, and at least one shown to be able to drive a reporter gene expression specifically in cells undergoing secondary cell wall synthesis, including in fibres. Such promoters may have potential applications in biotechnology to express transgenes to affect the fibre SCW.

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Development of a sensing system for automated cotton fruit load and vegetation estimation

Alison McCarthy and Nigel Hancock

National Centre for Engineering in Agriculture, University of Southern Queensland, Toowoomba, QLD

Stream: *NRM* **Oral**

Measurements of fruit load and vegetation indices can be useful for monitoring plant growth stages and condition and informing management decisions (e.g. irrigation volume and timing). However, these measurements are laborious to collect in broad-acre field situations. A camera-based sensing system has been developed to automatically estimate cotton fruit load and leaf area index in cotton. The system uses three cameras to capture overhead views of the crop canopy and an ultrasonic distance sensor to measure crop height. The captured images are analysed to estimate plant density, flower count and boll count, whilst the height is used to estimate the leaf area index of the crop. Three platforms have been developed to convey the sensing system over the field, two ground-based vehicle configurations (one manual, one motorised), and an overhead system which can be mounted on a centre pivot or lateral move irrigation machine. The ground-based systems were evaluated in the 2010/11, 2011/12 and 2012/13 cotton growing seasons, and the overhead-based sensor in the 2012/13 season. This paper describes the developed system and presents an evaluation of the system in cotton at different crop growth stages and lighting conditions. It is concluded that the plant height can be estimated using non-contact sensors under field conditions and plant density and flower count can be estimated from the top view images. However, the overhead cameras underestimated the boll count as the bolls were generally located lower on the plant.

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A new semiochemical biopesticide for cotton pest management

Robert Mensah[*1], Christopher Moore[2], Nick Watts[3], Myrna Deseo[4], Peter Glennie[5] & Angela Pitt[1]

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Stream: *Pest Management* **Oral**

The Australian cotton production system is dominated by transgenic Bt (Bollgard II®) cotton varieties. These provide good control of lepidopteran pests (*Helicoverpa spp.*) but are not effective against sucking pests. Recent trends in the frequency of resistance alleles in *Helicoverpa spp.* indicate the threat of pest resistance. Consequently, new technologies are required to manage the development of resistance and the resurgence of sucking pests. The objective of this study was to develop short-range nonvolatile plant compounds into a semiochemical product able to deter *Helicoverpa spp.* feeding and oviposition, and to cause toxicity to insect pests. Plants including sorghum, sweet corn, pigeon pea and lucerne (used as refuge crops in cotton), the cotton genotypes (MHR11, Lumein and Sicala VII) and a native plant *Clitoria ternatea* were cultivated within cotton crops and in cages, and assessed for the occurrence of oviposition by *Helicoverpa spp.* and survival of the pest larvae. The results showed that pigeon pea, cotton, sorghum and sweet corn were most preferred for *Helicoverpa spp.* oviposition and feeding, whereas *C. ternatea* was least preferred. We used a solid phase extraction technique to obtain six fractions of an extract of *C. ternatea*, which we assessed for bioactivity against *Helicoverpa spp.* We found that fractions 2, 3, 4 and 6 had oviposition and feeding deterrence as well as direct toxicity to *Helicoverpa spp.* The C. ternatea fractions have been developed into a product (Sero X®) that is effective against *Helicoverpa spp.* and sucking pests, and is in an advanced stage of commercialization.

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Morphology and tensile properties of bast fibres extracted from cotton stalks

Menghe Miao, Alban Yzombard and Stuart Gordon

CSIRO Materials Science and Engineering

Stream: *Post Harvest* **Oral**

Bast fibre contained in cotton stalk, a residue from the growth of cotton fibre, is available in very large quantity, estimated more than 15 million tonnes annually. The stalk is currently burnt or buried into soil. In this study, bast fibres were extracted from cotton stalk using a mechanical decortication method. The morphology of single bast fibre, or ultimate, was characterized by an effective diameter and a cell wall thickening factor (maturity) derived from a concentric circle model reconstructed using an image analysis technique. Fibre cells within the same plant are quite consistent in diameter but can vary considerably in maturity depending on their position in the plant. 80% of the bast fibres are contained in the lower half of the stalk where the fibre maturity is high. Cotton bast fibres are as strong as other bast fibres such as jute and hemp and can be used as reinforcement for polymer composite materials.

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Mechanisms of plant resistance to silverleaf whitefly in cotton

Junji Miyazaki, Warwick N. Stiller and Lewis J. Wilson

CSIRO Plant Industry

Stream: *Pest Management* **Oral**

Silverleaf whitefly (SLW), *Bemisia tabaci* (Gennadius) B Biotype, is a problem in all Australian cotton regions, due to potential for honeydew contamination of lint. SLW can be difficult and expensive to manage so plant resistance to reduce risks would be valuable. We investigated the host plant resistance to SLW of ten cotton Gossypium genotypes including tetraploid (*G. hirsutum* L., *G. barbadense* L.) and diploid (*G. arboreum* L., *G. thurberi* Tod. and *G. trilobum* (DC.) Skovst) species in field and glasshouse experiments. Population development of adult and nymph SLW stages between genotypes was compared, together with adult preference, oviposition preference and immature development. Resistance to SLW was found in genotypes with okra and/or glabrous leaf traits as well as in *G. arboreum* genotypes that had hairy normal shaped leaves. However, it was unlikely that hairiness per se was the cause of resistance as hairs were not close enough to each other to interfere with SLW development. This study revealed three distinct host plant resistance mechanisms against SLW; (1) okra leaf traits reducing adult preference, (2) glabrous leaf traits reducing oviposition preference and (3) possible biochemical traits in *G. arboreum* reducing immature development and/or survival. Although any potential negative effects of these traits on yield would need to be carefully evaluated, these traits are clear targets for breeding to develop host plant resistant cultivars to SLW.

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Improving disease resistance in cotton using marker assisted breeding

Nicole Mossfield, Tanya Phongkham, Vanessa Gillespie, Qian-Hao Zhu, Warwick Stiller, Danny Llewellyn and Iain W. Wilson

CSIRO Plant Industry

Stream: *Breeding* **Oral**

Diseases of cotton are responsible for significant and widespread decreases to production. Reducing the impact of major pests and diseases therefore represents an effective way to realise the true yield potential of elite varieties, and breeding resistant germplasm is the most effective long term means for minimising these losses. There have been some notable successes with improved varietal resistance to Bacterial Blight resulting in both yield and variety success. However, for many important cotton diseases it remains difficult or very slow to improve varietal resistance due to the genetic complexity of resistance or the difficulty in assaying for resistance in the field. Molecular markers are DNA tags or sequence differences that are physically located on cotton chromosomes near regions carrying important traits like disease resistance, and so can be used as a substitute to screen for the presence of those traits without ever exposing the plant to the disease causing organism. Possessing markers for disease resistance can greatly speed up the selection for resistant plants as it reduces the need to perform unreliable disease assays in the field. Analysis of populations segregating for Cotton Bunchy Top, Black Root Rot and Verticillium Wilt have identified regions in CSIRO germplasm linked to resistance for these diseases. The mapping of these resistance loci and the application of these markers for breeding varieties with increased resistance will be discussed.

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Aminoethoxyvinylglycine (AVG)-induced improved growth and fruit retention mitigate yield losses in waterlogged cotton

Ullah Najeeb[1], Daniel K.Y. Tan[1], Michael P. Bange[2,1]

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Stream: *Agronomy and Soils* **Oral**

Increased ethylene biosynthesis in waterlogged soils can cause growth inhibition and fruit abscission in cotton. A glasshouse experiment was conducted to optimise rate and application time of an anti-ethylene agent aminoethoxyvinylglycine (AVG) for ameliorating waterlogging-induced damage. Plants were grown in plastic pots, and were exposed to waterlogging for 3 weeks at the early flowering stage (65 days after sowing). Various concentrations of AVG (0, 50, 100 and 150 g [ai] ha^{-1}) were applied either 24h before or 24h after initiation of waterlogging. Data on plant height, dry biomass, leaf nutrient contents, SPAD, and fruit retention was recorded during and one week after termination of waterlogging. Significant reduction in plant growth and nutrient uptake was recorded in waterlogged cotton. Long term waterlogging reduced plant height as compared to control plants by 23%, dry biomass by 31%, and fruit retention by 43%. Waterlogged cotton sprayed with 150 g [ai] ha^{-1} AVG exhibited improvement in plant height by 11%, dry weight by 21 % and fruit retention by 25% compared to waterlogged only plants. The data indicated that pre-waterlogging AVG application has a potential to meliorate waterlogging-induced damage in cotton possibly by limiting ethylene biosynthesis. Further studies are needed to understand AVG action mechanism in waterlogged cotton.

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Some Quirks of the HVI: Opportunities for improved fibre strength and elongation by simply managing fibre length!

Geoffrey RS Naylor[1], Chris Delhom[2], Xiaoliang (Leon) Cui[2], Jean-Paul Gourlot[3] and James Rodgers[2]

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Stream: *Post Harvest* **Oral**

Studies have confirmed the influence of cotton fiber length characteristics on the HVITM strength and elongation measurement. This has been investigated and confirmed to be an instrument artefact rather than reflecting a real change in actual fibre properties. Some insights into the causes of these phenomena will be discussed. From a commercial perspective, this implies that any strategies to increase fibre length will result in winning the trifecta, namely HVI length strength and elongation values will all improve. This increases the importance of preserving fibre length particularly during harvesting and ginning.

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Helicoverpa spp. response to landscape structure

Cate Paull and Nancy Schellhorn

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Stream: *Pest Management* **Oral**

Helicoverpa punctigera and *Helicoverpa armigera* are highly mobile, existing across broad-acre landscapes where the composition of crops are constantly changing, yet little is known about how they respond to these landscapes dynamics. Data were collected over three years on the abundance of Helicoverpa spp (eggs and moths) in Bt cotton and sorghum at the spatial scale of fields, groups of fields and landscapes (20 km diameter) across the Darling Downs, QLD. Detailed land-use metrics were generated at various distances from each sampled field. These data were combined and used in spatially-explicit statistical analyses to identify and predict how crop composition and configuration at the landscape-level and field-level influence Helicoverpa egg and moth density. Using a range of landscape predictors we showed that crop amount and arrangement can explain a significant amount of variation in *H. armigera* egg density across landscapes. The presence of large areas of Bt cotton at the scale of a landscape has the biggest effect, more so than the immediate surrounding fields, and results in fewer eggs in Bt cotton. In addition, sorghum fields surrounded by large areas of Bt cotton had eight times higher egg density than sorghum fields surrounded by sorghum. In comparison *H. punctigera* appears to interact with crops at a much greater spatial scale. These results show how changes in the type, amount and location of crops, especially Bt cotton, and sorghum influence *H. armigera* behaviour, and will be important for informing future area-wide pest and resistance management strategies.

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The pattern of cell wall polysaccharide deposition in cotton seed fibres differs for different species and in different seasons

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Stream: *Breeding* **Oral**

Cotton seed fibres are single-celled epidermal trichomes that first appear on the surface of the ovule at anthesis. These fibres elongate over a period of 10-20 days until transitioning to a secondary cell wall stage marked by the increased deposition of cellulose and cessation of elongation. The composition of the wall during early stages of fibre development differs considerably from that of mature fibre which consists primarily of cellulose. A detailed analysis of cell wall composition was used to identify the polysaccharides in mature cotton fibre. Polysaccharide analysis of fibre from 5 days post anthesis to maturity for *Gossypium hirsutum*, *G. barbadense* and *G. arboreum* showed that cell wall polysaccharide changes that occur during fibre development progressed differently for each species. The plants were grown in the glasshouse during winter and summer and within each species cell wall development was different for each season. These results suggest that cell wall polysaccharide development, that impacts on fibre quality, is influenced by both genetic and environmental factors.

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Cotton-corn farming systems in the Namoi Valley – A life cycle assessment

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Stream: *Agronomy and Soils* **Oral**

Life Cycle Assessment (LCA) is commonly applied to identify greenhouse gas emissions arising from agricultural and industrial production. Greenhouse emissions were determined for the life cycle from "cradle-to-gate" of different cotton and corn production systems in the Namoi Valley, Australia. Analysis was based on data from three co-operating growers in the lower Namoi Valley and a long term experiment at the Australian Cotton Research Institute (ACRI) at Myall Vale, obtained through farmer interviews using a questionnaire. Analysis was conducted using SimaPro software, drawing background data from international databases. Greenhouse gas emissions averaged 345 kg CO_2-e for the production of 1 tonne of cotton lint and seed for both irrigated and dryland cotton and 325 kg CO_2-e for the production of 1 tonne of corn. The emissions profile for irrigated cotton grown in rotation included N_2O directly from fertilisers (35.3%), production of fertilisers (14%), CO_2 emissions from the use of nitrogenous fertilisers (11.6%), N_2O emissions indirectly via leaching (7.2%), N_2O emissions via volatilisation and indirectly from fertiliser re-deposition (3.8%), CO_2 emissions from on-farm combustion (7.8%) and irrigation (9.2%). The emissions were dominated by the production and use of nitrogenous fertilisers, at 72% for cotton and 65% for corn. Replacing these fertilisers with biologically fixed N using a legume-based system may reduce these emissions.

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Inducible tolerance to *Bacillus thuringiensis* toxins and emamectin benzoate in Lepidopteron insects

Mahbub Rahman[1,5], Otto Schmidt[1*], Greg Baker[2], Mary Whitehouse[3], Mike Keller[1] and Rick Roush[4]

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Stream: *Pest Management* **Oral**

Field surveys of insect pest populations in agroecosystems reveal low but significant levels of tolerance to synthetic and biological pesticides without mutational changes in resistance alleles. These effects seem to be separate from target site mutations, providing protection from low to medium pesticide doses. We have been studying possible mechanism/s that provide tolerance to low or medium pesticide doses (and its implications to overall resistance) in three lepidopteran insect species: flour moth *Ephestia kuehniella*, diamondback moth *Plutella xylostella* and cotton bollworm *Helicoverpa armigera*. The larvae of the moths were exposed in the laboratory to low or medium levels of emamectin benzoate and/or Bt toxins. Although the mechanism/s initially provide tolerance to low concentrations of toxins, the level of tolerance is increased by increments if the selection pressure is maintained over subsequent generations. Prolonged exposure to the pesticide may provide tolerant insect populations with the adaptive potential to acquire resistance mechanisms that are transmitted by genetic means. Consequently, these findings demonstrate that in addition to genetic resistance based on target site mutations (which produces individuals resistant to high toxin concentrations) exposure of insect larvae to low levels of toxin can cause the induction of immune and metabolic responses, resulting in low-level resistance (inducible tolerance). Tolerance to toxins such as Bt in insect populations, that can be transmitted to offspring by epigenetic inheritance mechanisms (caused by gene and protein regulatory mechanisms) has major ramifications to maintaining the efficacy of Bt cotton.

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Behavioral ecology of wolf spiders in cotton fields: implications for the control of insecticide-resistant cotton bollworms

Dalila Rendon[1,2] Mary Whitehouse[2] Phillip Taylor[1]

[1]Macquarie University, [2]CSIRO Ecosystem Sciences

Stream: *Pest Management* **Oral**

Insecticide-resistant cotton bollworms (Helicoverpa) survive on genetically modified cotton, and after the larva forages on cotton plants, it descends to pupate underground before emerging as a moth. During this ground-dwelling stage, Helicoverpa is at risk of attack by diverse predators, including a common inhabitant of cotton agroecosystems, the wolf spider *Tasmanicosa leuckartii*. Predation of Helicoverpa by wolf spiders reduces densities of Helicoverpa that emerge into the next generation carrying insecticide-resistant genes. This is of particular importance in minimum-tillage fields, where the effectiveness of pupae busting may be reduced, and the abundance of wolf spiders can be affected. This project examines the ecological effects of minimum-tillage on biodiversity of wolf spiders, and the effectiveness of wolf spiders at preying on Helicoverpa and reducing their densities. Results show that more complex cotton fields have a higher biodiversity of wolf spiders, and it affects the abundance of one particular species, *Tasmanicosa leuckartii*. In laboratory trials, most larvae (66%) and moths (77%) were attacked by *Tasmanicosa leuckartii*, and we found no evidence that attack was predicted by prey size, spider sex or spider stage. In addition, in glasshouse enclosures the presence of a spider reduced by 66% the proportion of emerging moths by direct predation. These results suggest that *Tasmanicosa leuckartii* is an effective predator at any life stage, and that its abundance can be enhanced by less disrupting farming practices.

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Types of deep drainage under irrigated cotton farming systems on a cracking clay soil

Anthony Ringrose-Voase and Tony Nadelko

CSIRO Land and Water

Stream: *Agronomy and Soils* **Oral**

Deep drainage under irrigated cotton can waste a scarce resource and lead to salinity problems if it causes watertables to rise. The magnitude, timing and process of drainage under a cotton-wheat rotation on a cracking clay has been investigated using the variable tension lysimeter at the Australian Cotton Research Institute near Narrabri since October 2006. The lysimeter allows accurate, high frequency measurement of drainage. Over the three cotton seasons for which drainage was measured, 0 to 73 mm of drainage per season was recorded. The high frequency measurements revealed there were two types of drainage – matrix and bypass. Matrix drainage occurred at relatively low rates of 0.5 mm/day over extended periods of a month during wet periods when rainfall exceeded ET causing a wetting front to move down the profile until it passed out of the root zone. Bypass flow occurred after furrow irrigation with peak rates of up to 3.2 mm/day 25 hours after irrigation. The water content and soil water potential of the soil at 1-2 m depth remained largely unaffected by the irrigation, showing that water was bypassing the soil matrix and travelling via macropores. Bypass drainage accounted for most drainage during the two year rotation. Drainage was greatest after irrigations early in the season necessitated by low, early season rainfall. Apart from lowering water use efficiency it also means a higher leaching fraction is required to prevent a build up of salt, because bypass drainage is less efficient at removing salt.

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A revised NutriLOGIC program to better predict Nitrogen fertiliser requirement

Ian Rochester

CSIRO Plant Industry, Narrabri

Stream: *Agronomy and Soils* **Oral**

NutriLOGIC is a decision support program that interprets data from soil and plant analyses to indicate whether fertiliser is required and the amount to apply in order to optimise lint yield. The soil component of NutriLOGIC provides interpretations with respect to N, P, K and S. The nitrogen component is currently being revised using data derived from cropping systems experiments at ACRI during the past 8 years, where yields have reached 14.5 bales/ha. The revised model has become more sophisticated as it requires an input of the recent lint yield achieved from a specific field. The model still relies on inputs of the past rotation crop, soil texture, degree of soil compaction and the cotton-growing region. The program determines an appropriate N fertiliser recommendation based on the amount of N provided by the soil, the amount of N fertiliser required to achieve the yield potential of the field and the proportion of fertiliser-N recovered by the cotton crop.

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Managing Fusarium wilt of cotton with rotation options

Linda Scheikowski[1], LindaSmith[2] and John Lehane[1]

[1]DAFF Qld, Toowoomba, [2]DAFF Qld, Brisbane

Stream: *Pest Management* **Oral**

Fusarium wilt of cotton is caused by the soilborne fungus Fusarium oxysporum f.sp. vasinfectum. Since its initial detection on the Darling Downs, Queensland, in 1993 Fusarium wilt has caused varying levels of economic losses in cotton production. In order to continue to sustainably produce cotton, growers need to implement an integrated disease management strategy. Some of these strategies include growing the most resistant cultivars available, delayed planting, farm hygiene and crop rotation. Studies have indicated that incorporating a bare fallow rotation into the farming system is often the best option to reduce inoculum levels of this pathogen. Either a summer sorghum or maize – fallow – cotton rotation can increase cotton plant survival, reduce disease incidence and increase yield in the third year compared to growing three years of continuous cotton. Research has highlighted that some legumes may increase disease compared to other rotation options. The ability of this pathogen to survive saprophytically on crop residue and organic matter also needs to be taken into consideration.

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Cotton bunchy top virus and other relatives

Murray Sharman[1], Lewis Wilson[2], Tanya Smith[2], Matt Webb[1], Paul Grundy[1], Marc Ellis[2], Cherie Gambley[1], John Thomas[3], Marc Giband[4], Nelson Suassuna[5], Jean-Louis Belot[6], Siwilai Lapbanjob[7], Kanjana Warawichanee[7]

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Stream: *Pest Management* **Oral**

Cotton bunchy top virus (CBTV) and the related Cotton leafroll dwarf virus (CLRDV) have caused sporadic disease outbreaks in most cotton regions of the world. Until recently, little was known about the diversity of CBTV or its natural host range. Seven natural field hosts and one experimental host of CBTV have now been identified. These include cotton, *Malva parviflora* (Marshmallow weed), *Abutilon theophrasti* (Velvetleaf), *Anoda cristata* (Spurred anoda), *Hibiscus sabdariffa* (Rosella), *Sida rhombifolia* (Paddy's lucerne), *Chamaesyce hirta* (Asthma plant) and *Gossypium australe*. These are currently the only eight known hosts of CBTV. However the virus may have a wider host range than originally thought and include further non-Malvaceae species like asthma plant (family Euphorbiaceae). There are two distinct strains of CBTV in Australia, -A and –B, which have been detected in cotton from numerous locations across almost all growing regions. From 105 samples of cotton that have been positive for CBTV, 6 were infections of strain A only, 60 were strain B only and 64 were a mixed infection of strains A and B. These results indicate the symptoms of cotton bunchy top disease are closely associated with the presence of strain CBTV-B. A diagnostic assay for Cotton leafroll dwarf virus (CLRDV – cotton blue disease) is being developed and applied successfully for the detection of CLRDV samples from Brazil and Thailand. This is the first confirmation of CLRDV from SE-Asia, which may pose an increased biosecurity threat to the Australian industry.

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Understanding the underlying physiology and photosynthetic biochemistry contributing to thermotolerance and water use efficiency amongst cotton genotypes.

Robert E. Sharwood[1], Oula Ghannoum[1], Balasaheb Sonawane[1], Michael Bange[2] and David Tissue[1]

[1]Hawkesbury Institute for the Environment,University of Western Sydney. [2]CSIRO Plant Industry

Stream: *Agronomy and Soils* **Oral**

Global climate change resulting in increased drought and higher ambient air temperatures may severely impact future productivity of the cotton industry. Identification of thermo-tolerant and water use efficient (WUE) cotton lines by CSIRO through plant breeding efforts may be utilized to maintain productivity despite unfavorable climate. CSIRO provided six cotton genotypes, which include DP16 (old genotype), Siokra L23 (WUE), CS50 (decreased WUE), 64224-212 (heat tolerant), SICALA V2 (poor heat tolerance) and the current industry standard Sicot 71, which we grew in a sun-lit glasshouse under non-limiting water and nitrogen conditions at mid-day maximum air temperatures of 28°C and 33°C. We measured plant growth, photosynthetic capacity, and online stable carbon isotope discrimination to calculate photosynthetic WUE and mesophyll conductance of CO_2 (gm). Elevated growth temperature accelerated the onset of flowering and boll formation, and increased plant mass and total leaf area across all genotypes. Preliminary analysis of gas-exchange data indicates photosynthetic capacity was increased in all genotypes when measured at 33°C compared to the identical lines at 28oC, irrespective of growth temperature. Stomatal conductance (gs) measured under saturating light conditions varied across the genotypes and all plants displayed a high thermal optimum of photosynthesis. To determine the biochemical basis of these the changes in growth and photosynthesis, we have sampled leaves to measure Rubisco content and activation, to assess the efficiency of carbon fixation in these genotypes.

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How predictable are the behavioral responses of insects to herbivore induced changes in plants? A case study into the complex interactions between three thrips species and their host plant cotton

Rehan Silva[1], Michael Furlong[1], Gimme Walter[1] and Lewis Wilson[2]

[1]School of Biological Sciences, The University of Queensland, [2]CSIRO Plant Industry.

Stream: *Pest Management* **Oral**

Changes in plants following insect attack are referred to as induced responses. These responses are widely viewed as a form of defence against further insect attack. Reduced rates of attraction of certain herbivores to damaged plants are cited as evidence of a defensive role. To investigate the generality of the responses of herbivores to induced plants, experiments were conducted to test for consistency in the responses of three thrips species, *Frankliniella schultzei*, *F. occidentalis* and *Thrips tabaci*, to cotton seedlings damaged by various arthropod pests; cotton bollworm, two-spotted spider mites and mealworms. In dual-choice experiments that compared intact and damaged cotton seedlings, F. schultzei was attracted to seedlings damaged by these pests. In similar tests, *F. occidentalis* showed the opposite responses to *F. schultzei*; it was attracted to undamaged seedlings furthermore, *T. tabaci* exhibited different responses to both Frankliniella species; it did not show differential attraction between damaged and undamaged plants. The only consistency across all three species of thrips was their being uniformly attracted to T. urticae damaged plants. Attraction of thrips was also affected by herbivore density. Both *F. schultzei* and *T. tabaci* showed increased attraction to damaged seedlings as the density of *T. urticae*, *F. schultzei* or *T. tabaci* increased. In contrast, although *F. occidentalis* demonstrated increased attraction to plants damaged by higher densities of *T. urticae*, there was a negative relationship between attraction and the density of damaging conspecifics. Results demonstrate that the responses of all species of thrips are context dependent and difficult to predict.

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Developing a National framework to evaluate indicators for soil health monitoring

Prof Brajesh Kumar Singh

Hawkesbury Institute for the Environment, University of Western Sydney

Stream: *Agronomy and Soils* **Oral**

The soil health is the capacity of soil to functions as a vital living system able to fulfil all its functions including sustaining biological productivity, promoting environmental quality and maintaining plant, animal and human health. Soil chemistry, physics and biology are integral to this, and their complex interactions determine the soil health on which sustainable production depends. Soil biology is considered key in soil health as it regulates many soil physical and chemical properties including nutrient cycling and availability to plants. Until recently, due to immense diversity and high complexity, using components of soil biology as indicators of soil health was considered beyond immediate scope. However, recent advancements in both technologies to characterise soil biology and the theoretical framework to link this with important soil functions have provided the necessary evidence to use biological indicators for national-scale monitoring. In this talk, I will present my previous works on development of national scale soil quality indicators for UK and Scotland. These works resulted into the selection of robust, repeatable and auditable soil indicators. These projects developed a structured framework called "logical sieve" which identified priority indicators and logistic associated with deployment at national scale. I will then highlight how such an approach is applicable to the Australian national programme on soil health including GRDC's Soil Biology Initiative II and how this can be adopted for cotton farming region in Australia for routine monitoring activities in order to ensure enhanced and sustainable farm productivity for cotton industries.

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Reniform nematode (*rotylenchulus reniformis* Linford and Oliveira, 1940): first detections in Australian cotton and survey in central Queensland

Linda Smith[1], Jenny Cobon1, Wayne O'Neill[1], Bartley Bauer[1], Linda Scheikowski[2] and John Lehane.[2]

[1]DAFF (Qld), Brisbane [2]DAFF (Qld), Toowoomba

Stream: *Pest Management* **Oral**

The reniform nematode, *Rotylenchulus reniformis* Linford and Oliveira, 1940, is a major pest in the USA cotton industry, responsible for annual losses of $130 M. In Australia, this species occurs in some horticultural crops in Queensland. In November 2012, reniform nematodes were identified in cotton production in the Theodore region. Apart from an isolated detection in Emerald in 2003, this represents the first recorded incidence of reniform nematodes in the Australian cotton industry. In order to delineate the pest distribution quantitatively, a systematic survey of cotton fields in the Theodore area was conducted. Soil samples were collected postharvest for each 10 ha section of fields during the autumn and winter of 2013. Extraction of nematodes from soil subsamples was achieved by saturation with water for 72 hours (Whitehead tray method) prior to morphological identification and quantification using light microscopy. Reniform nematodes were found to be widespread, inhabiting 70-73% of fields in each of the Gibber Gunyah, Theodore West and Theodore East districts. Properties to the south of Theodore are less geographically clustered and displayed greater variation in pest incidence (50% of sampled fields infested). Further sampling of the initial site in Emerald determined that reniform nematodes are still present and more extensive surveying of the Emerald region is required. Further data collection is required to establish economic thresholds to enable prediction of potential yield decrease associated with a population density.

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The influence of N, P and K on severity of Fusarium Wilt of cotton

Linda Smith[1], Linda Scheikowski[2], and John Lehane[2]

[1]DAFF Qld, Brisbane and [2]DAFF Qld, Toowoomba

Stream: *Pest Management* **Oral**

Fusarium wilt of cotton caused by the soilborne fungus Fusarium oxysporum f.sp. vasinfectum was first detected on the Darling Downs, Queensland, in 1993. Today this pathogen continues to cause significant losses to Australian cotton production when environmental conditions are conducive to disease development. For the continuation of sustainable cotton production, an integrated disease management approach is required, which includes growing high F-ranked varieties, delayed planting, farm hygiene and crop rotation. But how does nutrition influence disease severity? Nutrition is frequently unrecognized as a primary component of disease control. Although the plant's defences to infection are under genetic control, their metabolic expression is regulated by mineral ions. Nitrogen (N), phosphorus (P) and potassium (K) are essential nutrients for plant growth and have been shown to influence the severity of Fusarium wilt of cotton in studies conducted overseas. Glasshouse trials determined that Fusarium wilt severity is greatly influenced by the balance of N, P and K, as disease severity ranged from disease-free plants to dead plants depending on the combination. Higher disease ratings tended to have lower levels of nutrients added, particularly low N and no P, and lower disease ratings tended to have higher N and some P. The lowest level of disease was observed when 5 kg/ha of P, 250 kg/ha of N and 100 kg/ha of K was applied.

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Breeding of elite Genuity™ Bollgard III® cultivars

Warwick Stiller, Greg Constable and Shiming Liu

CSIRO Plant Industry, 21888 Kamilaroi Hwy, Narrabri, NSW 2390

Stream: *Breeding* **Oral**

The Genuity™ Bollgard III® technology from Monsanto is being introduced to the Australian cotton industry to strengthen the resistance management package for plant based Helicoverpa control. It is expected that this trait package will be phased in from 2015 to replace Bollgard II® assuming approval by regulatory authorities and the availability of cultivars. Bollgard III® contains an additional gene (VIP3A) added to the existing Cry1Ac and Cry2Ab of Bollgard II®. From a breeding perspective, the more traits a cultivar is required to contain – the greater the complexity in breeding and potentially the longer the timelines for development. Cotton growers are very rapid adopters of new cultivars. In the 2013 sowing, it is likely that 75% of seed sales will be one cultivar in only its fourth year of commercial use. The popularity of that cultivar (Sicot 74BRF) is based on prodigious yield potential, combined with regional adaptation, stability, good fibre quality and a wide disease resistance package. It is difficult to develop a new cultivar containing four independent GM events which equals or especially exceeds Sicot 74BRF in performance. Growers would be reluctant to adopt a cultivar which did not meet their expectations based on performance of existing cultivars - let alone continue historical improvements in yield, fibre quality and disease resistance. This paper discusses the challenges associated with developing new Bollgard III® cultivars for delivery to an industry that already has very high yielding cultivars with excellent fibre quality and disease resistance.

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Breeding for disease resistance in cotton: outcomes and challenges

Warwick Stiller[1], Peter Reid[1], Iain Wilson[2] and Greg Constable[1]

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Stream: *Breeding* **Oral**

The impact that diseases have on cotton production in Australia vary between seasons and regions. Significant advances in disease resistance through breeding have been made over the last 30 years to the point where some diseases are not seen or do not constrain cotton production. However, some diseases still pose a significant risk to production and improvements in cultivar resistance is required. This includes disease such as fusarium wilt, verticillium wilt, black root rot and cotton bunchy top (CBT). Traditionally, all screening was done in field nurseries and resistance assessment was by measuring survival of plants and/or absence of symptoms in comparison with a standard cultivar. However, in recent years, considerable research has focused on discovering and deploying molecular markers to assist in the breeding of resistant cultivars. The first of these to be used routinely is for CBT. Traditional breeding has continued to focus on discovering higher levels of resistance in exotic cultivars, landrace cottons and other related species. In a number of cases, higher levels of resistance compared with the current beat cultivars have been discovered and work has started to transfer this improved resistance into elite cultivars. This paper outlines the progress to date in breeding for resistance to a range of diseases as well as highlighting some challenges that need to be overcome.

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The ecology of facultative fungal endophytes in cotton agroecosystems

Gregory A. Sword

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Stream: *Pest Management* **Oral**

Beneficial fungal endophytes have the potential to confer protection to plants from a variety of stressors including nematodes, insects, pathogens and environmental conditions such as drought. As part of a survey of fungal endophyte diversity in cultivated cotton, we have recovered a number of potentially beneficial candidate endophytes. In lab and greenhouse tests, specific candidate fungal endophytes can be selectively inoculated to live within cotton. When present as endophytes they can affect the performance and host plant selection behaviour of a wide range of insect and nematode herbivores. As a key step in utilizing fungal endophytes for the management of cotton pests, we evaluated the ability to selectively manipulate cotton-endophyte interactions under natural field conditions in a multi-year study. Cotton seeds inoculated with different spore concentrations of two different candidate fungal endophyte species were planted in the field using a replicated, randomized block design. Endophytic colonization frequencies for both species of endophyte were high, but variable across years based on assays of surface sterilized seedlings. Cotton plants inoculated with either of the two candidate endophytes differed from uninoculated control plants in several ways including harbouring fewer insects, reduced herbivore damage, increased fruit retention and higher yields. These results constitute a novel field-scale demonstration of targeted fungal endophyte manipulation in cotton and provide the basis for more thorough evaluations of an expanded range of potentially beneficial fungal endophytes.

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Making use of the *Helicoverpa armigera* genome.

The Helicoverpa genome consortium and Wee Tek Tay[1], Miguel F. Soria[2], **Thomas Walsh[1]**, Danielle Thomazoni[2], Pierre Silvie[3], Gajanan T. Behere[4] Craig Anderson[1] and Sharon Downes[1]

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Stream: *Pest Management* **Oral**

Helicoverpa armigera is one of the most destructive pests of cotton around the world. The Helicoverpa genome project is currently underway and nearing completion. This resource will provide a basis for future research into a number of different fields. In particular, it has enabled us to identify the resistance mechanisms for a number of insecticides. We have also used the genome to answer important questions related to the global population of *H. armigera*. Furthermore we have been able to use this resource to address questions raised by the recent incursion of *H. armigera* into Brazil. Historically *H. armigera* is thought to have colonised the American continents around 1.5 to 2 million years ago, leading to the founding of current *H. zea* populations in the American continents. The relatively recent species divergence history is evident in mating compatibility between *H. zea* and *H. armigera* under laboratory conditions. Despite periodic interceptions of *H. armigera* in northern America, this pest species is not believed to have successfully established significant populations in these continents. We will provide molecular evidence via mitochondrial DNA (mtDNA) of the recent incursion of *H. armigera* into the New World, with populations from the State of Mato Grosso in Brazil likely to have arrived post 2006. The genome will play an important role in understanding the dynamics of *H. armigera* in Brazil including the possibility of hybridisation with the native species, *H. zea*.

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A new model for testing field-level epidemiology of herbicide resistance in cotton

David Thornby and Jeff Werth

Queensland Department of Agriculture, Fisheries and Forestry

Stream: *Pest Management* **Oral**

In Australian agriculture, the emphasis on dealing with herbicide resistance is shifting from prevention to management. So many land managers are confronted with a population of resistant weeds that it makes sense to develop strategies for dealing with resistance that exists, rather than resistance that is evolving. We have developed a good understanding of how, why, and when resistance occurs, and this knowledge underpins current management recommendations. Nevertheless, practical questions remain about the epidemiology of resistance: where it occurs in space, how patches grow and spawn new patches, and at what rate these processes occur for different species. Answers to these questions will help us decide whether zonal management or local eradication of resistance are feasible goals. In order to examine the spatial dynamics of resistance, we developed SHeRA, the Spatial Herbicide Resistance Analyser. Sub-populations of weeds of 1 m2 each, arranged in a grid, are subjected to various management tactics and communicate with each other through movement of pollen and seeds. We estimated parameters to test the patch dynamics of glyphosate-resistant awnless barnyard grass in glyphosate-resistant cotton farming. We intend to use SHeRA to investigate the potential for eradicating glyphosate-resistant patches of awnless barnyard grass in Australian cotton farming, and to optimise zonal management strategies. We hope to develop quantified recommendations for on-farm use where early identification of glyphosate-resistant barnyard grass occurs. The development and implementation of such strategies will be critical in determining the medium- to long-term sustainability of glyphosate-tolerant cotton farming in Australia.

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Combining GIS, remote sensing, and simulation modeling for spatial analysis of seed cotton yield and evapotranspiration in central Arizona, USA

Kelly R. Thorp, Douglas J. Hunsaker, Andrew N. French and Eduardo Bautista

United States Department of Agriculture, Agricultural Research Service, Arid-Land Agricultural Research Center

Stream: *Agronomy and Soils* **Oral**

Precision irrigation water management requires the synthesis of several informational technologies, including geographic information systems (GIS), remote sensing, and cropping system simulation models. Our objective was to develop software tools and data processing pipelines that can be used for managing data streams from remote sensing instruments, merging site-specific remote sensing data into simulation models, and implementing the models for analysis of irrigation management alternatives and irrigation scheduling. A software 'plug-in' for the open-source Quantum GIS has been developed to accomplish required geoprocessing tasks, including processing raster and vector data layers within predefined management zones and running simulation models with site-specific data. The plug-in was designed to be model independent, meaning the software can interact with the input and output files of any simulation model. Testing and refinement of these geoprocessing tools were accomplished using data from two precision irrigation experiments for surface-irrigated cotton, conducted at Maricopa, Arizona during the summers of 2009 and 2011. Canopy spectral reflectance and canopy temperature data from airborne imagers were processed within predefined management zones. Site-specific soil texture information based on field sampling was interpolated and averaged within each management zone. Spatial data were integrated into site-specific simulations with the DSSAT-CSM-CROPGRO-Cotton model. Simulated annealing optimization was used to calibrate the model uniquely for each management zone by minimizing error between measured and simulated leaf area index (LAI), as estimated from normalized difference vegetation index (NDVI) and canopy height. Site-specific cotton yield and evapotranspiration simulations were compared with observations at the field site.

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Impact of elevated CO_2 and temperature on cotton growth and physiology under well-watered conditions

David Tissue[1], Renee Smith[1], Katie Broughton[2,3], Remko Duursma[1], Paxton Payton[4] and Michael Bange[3]

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Stream: *Agronomy and Soils* **Oral**

Two cultivars (DP16 and 71BRF) of cotton were grown from seed in a sunlit glasshouse for 5 weeks under well-watered, high nutrient conditions exposed to two atmospheric [CO_2] (400 ppm and 640 ppm) and two air temperature (Ambient and Amb +4C) treatments. Our objectives were to assess the impact of different climate change scenarios on vegetative growth and physiological performance. In general, the recently developed cultivar (71BRF) exhibited higher rates of photosynthesis, lower total biomass, and greater carbohydrate storage available for boll formation than the older cultivar (DP16). Elevated [CO_2] stimulated vegetative mass production (35%), leaf area (15%) and photosynthesis (40%), while marginally reducing stomatal conductance, thereby substantially increasing water use efficiency (WUE) under growth conditions. Elevated temperature substantially increased vegetative mass (100%), leaf area (100%), and respiration (40%), but not photosynthesis or stomatal conductance. Across an experimentally manipulated vapour pressure deficit (VPD) range of 1-4 kPa, elevated [CO_2] plants had 60% higher WUE than ambient [CO_2] plants, but elevated temperature did not affect WUE. Surprisingly, there were no significant CO_2 x temperature interactions in measured parameters. Leaf samples are currently being analysed for gene expression and metabolite profiling. In addition, a series of experiments have been (or will be) conducted to assess the impact of variable soil moisture on cotton response to elevated CO_2 x Temperature conditions in the glasshouse at UWS, in field trials in Texas, and in the field at Narrabri NSW to further assess cotton performance under projected future climate change conditions.

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Legacy soil and ancillary data: a “not so” lost opportunity for improved soil resource mapping and management?

John Triantafilis

The University of New South Wales

Stream: *Agronomy and Soils* **Oral**

In the late 1990’s and early 2000’s various soil related projects were funded by the CRDC and various editions of the cotton CRC. In this presentation a brief description of the soil and ancillary data collected and the way this legacy information has, is and could still be used to provide research and practical soil resource mapping and management outcomes is demonstrated. This includes, the potential to provide a digital soil map, which for the first time places into some context the differences and similarities of the soil types in various cotton growing valleys (e.g. Namoi, Gwydir, Macintyre, etc). This has implications for providing an independent evaluation of the land use potential of these areas, which could be used in relation to counter an independent analysis of the Strategic Agricultural Land; being prepared by the NSW Government and as part of the evaluation being considered by the Land and Water Commissioner. In addition, the information is useful in characterising the connectivity between surface and groundwater resources as well as modelling the spatial variation of prior stream and buried palaeochannels, which quite often lead to poor water use efficiency, rising water tables and in some instances soil salinisation.

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Comparing cotton fibre quality from conventional and round module harvesting methods

Rene van der Sluijs[1], Robert Long[1] and Michael Bange[2]

[1]CSIRO Materials Science and Engineering, [2]CSIRO Plant Industry

Stream: *Post Harvest* **Oral**

The introduction to the Australian cotton industry of the John Deere 7760 spindle harvester, with on board module building capacity producing round modules, has led to the rapid uptake by growers due to significant savings in harvesting costs. In 2011/12 these harvesters picked approximately 75% of the crop. There have however, been anecdotal reports from cotton classing facilities that the quality of cotton harvested by the John Deere 7760 is inferior to that harvested by conventional spindle basket harvesters in terms of grade (a measure of fibre colour and trash content). So that direct comparisons could be made, four fields planted with the two most popular Upland varieties grown in Australia were harvested in the southern and central cotton growing areas of Australia utilizing both the round module and conventional basket harvesters. Alternate rows across the fields were harvested using either of the two methods with harvested seed cotton being ginned at the same gin. Ginned fibre samples were assessed for fibre quality via a High Volume Instrument, visual classing, and the Advanced Fiber Information System. Results showed that there were no practical differences in the quality of the cotton lint from bales produced from either the round or conventional module harvesting methods.

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Building Geographic Information Systems for Australian cotton

Peter Verwey

NSW DPI

Stream: *Agronomy and Soils* **Oral**

A working Geographic Information System (GIS) integrates five key components: hardware, software, data, people, and methods. “Spatial Technologies in Australian Cotton” is a CRDC funded project hosted by NSW DPI. One of the key aims of this project is to design and build a GIS to support Australian cotton production and research. This presentation will explore the process of designing a cotton GIS and then discuss what that GIS can be expected to contribute to end users: cotton growers, researchers, consultants, and industry. Two key components of the GIS will be the cataloguing of research spatial metadata, and the development of a multi platform farm mapping solution integrated with myBMP. Spatial metadata is the information that describes where something has occurred. In a research context, spatial metadata describes where the research was conducted, what valley, locality, farm, field, or precise coordinates. Knowing where research has been conducted allows analysis of research effort to include the concept of place and to leverage that spatial context to link research findings by geography. Farm maps are a key component of myBMP and are often an under utilised resource on many farms. By developing a farm map GIS our aim is to provide a simple solution for growers to create and maintain their farm map, and then to extend its function through mobile apps that dynamically link to the farm map, for example allowing in-field viewing and manipulation of irrigation schedules, crop rotations, and recording of weed problem areas.

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Understanding the molecular basis of cotton fibre differentiation and initiation

Sally-Ann Walford, Frank Bedon, Lili Tu, Danny Llewellyn and Elizabeth S. Dennis

CSIRO Plant Industry

Stream: *Breeding* **Oral**

Cotton fibres are specialised epidermal cells that grow from the surface of the cotton seed. We have sought to identify regulatory genes that are important for instigating the development of these fibre cells and two R2-R3 MYBs (GhMYB25 and GhMYB25-like) and a homeodomain-leucine zipper protein (GhHD-1) were identified. GhMYB25-like and GhMYB25 belong to a unique MIXTA clade of MYB transcription factors involved in the regulation of cell morphogenesis in the petal epidermis. Another eight of these genes have been found in cotton and expression analysis has shown that they are all expressed during early fibre development. GhHD-1 is a member of the class IV HD-ZIP transcription factor family, known to be involved in the determination of epidermal cell type. RNAi-mediated suppression of GhHD-1 reduced trichome formation and delayed fibre initiation while constitutive over-expression of this gene increased the number of fibres initiating on the seed, but did not affect leaf trichomes. GhMYB25-silenced cotton exhibits delayed fibre initiation, shorter fibres and reduced trichomes on the plant, while over-expression of this gene increased fibre initiation and leaf trichome number. GhMYB25-like silenced plants produce fibreless seeds, but normal trichomes elsewhere. Constitutive over-expression of GhMYB25-like increased the number of fibre initials. Yeast two-hybrid analysis and sequencing of RNA isolated from the outer integument of -4dpa, -2dpa and 0dpa ovules together with microarray analyses on cotton ovules from the silenced and over-expression lines at 0 dpa and wild-type cotton plants at -2dpa have identified additional proteins involved in the regulation of early fibre development.

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Managing herbicide resistance in cotton systems – have we covered everything?

Jeff Werth, David Thornby and Steve Walker

Queensland Department of Agriculture Fisheries and Forestry Queensland Alliance for Agriculture and Food Innovation

Stream: *Pest Management* **Oral**

Glyphosate resistance is now present in cotton systems, particularly in dryland systems where summer fallows are common. Glyphosate resistant populations of *Echinochloa colona* and *Conyza bonariensis* are widespread throughout the cotton growing region. *Lolium rigidum* and *Chloris truncata* populations resistant to glyphosate have recently been reported. The majority of current research has focused on managing resistant populations using herbicides other than glyphosate, applying the "double knock" technique and controlling survivors of glyphosate application. These tactics can be effective at delaying resistance evolution, as simulations and anecdotal field evidence has shown. However, relying totally on herbicides to prevent herbicide resistance will ultimately be unsuccessful. The key to a more sustainable system involves regular incorporation of non-herbicidal tactics. Some research has examined the effects of tillage on reducing emergences via seed burial, however we still don't know the potential impacts of pupae busting on preventing resistance evolution. The benefits of hand-hoeing are obvious, however due to perceived high costs of labour this tactic is underutilised. Crop competition in irrigated crops has been shown to be very effective at reducing reliance on herbicides; however this tactic is not effective in non-irrigated crops. If crop configurations can't be altered in non-irrigated crops, do we then need to focus our attention on other crops in the rotation. We have seen how glyphosate resistance has decimated cotton crops in the US. For glyphosate and other herbicides to be sustainable in the long-term, we need to be asking and addressing some of the hard questions now.

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Target and non-target effects of novel 'triple-stacked' Bt-transgenic cotton 1: canopy arthropod communities

M. E. A. Whitehouse[1*], L. J. Wilson[2] , A. P. Davies[1,3], D. Cross[1,4], P. Goldsmith[5], A. Thompson[1,6] , S. Harden[7], G. Baker[1]

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Stream: *Pest Management* **Oral**

Transgenic cotton varieties (Bollgard II®) expressing two proteins (Cry1Ac and Cry2Ab) from *Bacillus thuringiensis* (Bt) have been widely adopted in Australia to control larvae of *Helicoverpa spp.* A triple-stacked Bt-transgenic cotton producing Cry1Ac, Cry2Ab and Vip3A proteins (Genuity Bollgard III®) is being developed to reduce the chance that *Helicoverpa spp.* will develop resistance to the Bt proteins. Before its introduction, non-target effects on the agro-ecosystem need to be evaluated under field conditions. Using beatsheet and suction sampling methods we compared the invertebrate communities of unsprayed non-Bt cotton, Bollgard II and Bollgard III in 5 experiments across 3 sites in Australia. We found significant differences between invertebrate communities of non-Bt and Bt (Bollgard II and Bollgard III) cotton only in experiments where lepidopteran larval abundance was high. In beatsheet samples, changes in the community reflected a higher abundance of flowers and bolls in Bt cotton due to less feeding damage by lepidopterans. In suction sample data, insects usually associated with plant damage and lepidopteran frass were more common in non-Bt crops. Hence most differences between Bt and non-Bt communities reflected altered food availability for different functional groups. There was no overall significant difference between Bollgard II and III communities, despite the addition of the Vip gene in Bollgard III. Consequently, the use of Bollgard III in Australian cotton provides additional protection against the development of resistance by *Helicoverpa spp.* to Bt toxins, while having no additional effect on cotton invertebrate communities.

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Maintaining and improving refuges in cotton production systems.

Mary Whitehouse

CSIRO Ecosystem Sciences

Stream: *Pest Management* **Oral**

With the near universal adoption of Bollgard II cotton, *Helicoverpa* spp are under strong selection pressure to develop resistance to Bt toxins. The selection pressure is theoretically reduced using refuges, which are hypothesized to produce sufficient moths with non-resistant alleles to dilute any resistant alleles in moths emerging from the Bt crop. Currently two crops are used as refuges in cotton: non-Bt cotton and pigeon pea. To date, resistance has not developed, indicating that refuges have been effective. To maintain their efficacy, vigilance against complacency is vital. This work examines the adherence of refuges to simple assumptions upon which refuge models are based, particularly assumptions associated with pigeon pea refuges. Results confirm findings of extensive variability between the attractiveness and productivity of individual refuges, particularly pigeon pea. The work concludes that if the industry wants to maintain pigeon pea as a refuge, it needs to reduce this variance. To reduce variance, the work identifies that both refuge agronomy and pigeon pea seed quality need to be improved, and provides suggestions on how this could be achieved.

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A new online tool for predicting in-season micronaire of cotton

Sandra Williams, Michael Bange, Greg Constable, and Lotetta Clancy

CSIRO Plant Industry

Stream: *Agronomy and Soils* **Oral**

Micronaire is an indirect measurement of both fibre maturity and fineness (linear density). Differences in micronaire of cotton fibre can affect grower returns, and influence textile quality. Quantifying effects that influence micronaire are important so that crop management practices can be developed to optimise this quality attribute. Recently an online tool 'the micronaire predictor' has been developed as part of the CottASSIST online decision aid suite to assist crop managers to predict in-season micronaire from air temperature. The tool was developed using research that took existing data from sowing time experiments in Australia that spanned three decades, and developed a linear response of micronaire to daily average temperature during the crop boll filling period where the majority of bolls were undergoing fibre thickening (r^2 =0.57). Micronaire was successfully predicted on two independent datasets despite no account for other climate and management factors that may influence crop micronaire. The ability to predict temperature effects on micronaire will be useful to assess reasons for seasonal and regional differences in micronaire and assess opportunities to modify micronaire with changes in management practices (such as changes in planting time) that influence the timing of boll development

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The fate of honeydew in cotton.

Lewis Wilson[1] Simone Heimoana[1] Michael O'Shea[2] Paul De Barro[2] and Michael Priest[4]

[1]CSIRO Plant Industry [2]CSIRO Ecosystem Sciences [3]Bureaux of Sugar Experiment Stations [4]NSW DPI

Stream: *Pest Management* **Oral**

Cotton aphid and silverleaf whitefly are insect pests that feed on phloem sap and produce sugar rich honeydew that can contaminate cotton lint leading to downstream problems with processing. Despite established management strategies for these pests, honeydew contaminated crops still occur. Measuring the rate of decline in honeydew on these crops and the factors driving this decline is important in defining when they may be safe to harvest. We investigated the fate of honeydew by following the concentration of sugars on bolls contaminated with aphid or SLW honeydew or contaminated with artificial honeydew (constituted from sugars at ratios similar to those in SLW honeydew). Our results suggest that rainfall has the most immediate and rapid effect on the amount of honeydew on bolls, with 20 mm causing reductions of about 80%. The decline in the amount of honeydew in the absence of rainfall was generally very slow. We developed a simple artificial rainfall simulator and found a strong negative correlation between increasing artificial rainfall and honeydew concentration. However, artificial rainfall was not as effective as actual rainfall at removing honeydew. We suggest that the hydrophilic nature of cotton and the deposition of honeydew primarily on the outer surface of lint on the boll provides an ideal situation for rainfall to wash it off. This has important implications for SLW and aphid management as there is a risk of very slow reduction in honeydew in years where there are dry conditions late season and through the harvest period.

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A new concept for cotton fibre elongation

Shouren Yang and Stuart Gordon

CSIRO Materials Science and Engineering

Stream: *Post Harvest* **Oral**

A close examination on the measurement of cotton fibre elongation has been carried out on ten international cottons. These samples were tested using various techniques including the Favimat single fibre tester, HVI and the CSIRO Tensor bundle tester. The results show there were reasonably good correlations between Favimat single fibre elongation and Tensor bundle elongation values. Moreover, the correlation between these two testing methods was greatly improved by introducing a new concept of specific elongation, which is defined as the ratio of elongation value to the linear density of the fibre (or bundle) used in the test. By using the specific elongation the square of correlation coefficient between Favimat and Tensor elongation is improved from 0.61 to 0.82 for the ten cottons. However, there was no correlation between Favimat single fibre elongation and HVI bundle elongation. The poor correlation between HVI and Favimat elongation is confirmed in published data reported by other researchers. This study has also revealed strong positive correlations between single fibre tenacity and elongation for Favimat and between bundle tenacity and elongation for Tensor for the ten cottons. Again the use of specific elongation greatly improved the correlations in both cases but again did not improve the relationship between Favimat or Tensor and HVI. It is tentatively concluded that Favimat single fibre and Tensor bundle elongation measurements are adequate for ranking cotton on the basis of elongation and that HVI does not provide adequate measurement. Specific elongation is a useful and logical concept for cotton elongation studies. Further studies are needed to confirm these findings.

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Discovery of single nucleotide polymorphisms for applications in cotton genetics and breeding

Qian-Hao Zhu, Andrew Spriggs, Jen Taylor, Danny Llewellyn, Iain Wilson

CSIRO Plant Industry

Stream: *Breeding* **Oral**

Molecular markers are DNA differences between individuals that identify or tag particular regions of a genome of an organism and in plant breeding can be used to follow regions of a chromosome carrying a desirable trait through segregating populations or breeding lines. Single nucleotide polymorphisms (SNPs) are the most abundant type of molecular markers in plants and are used for quantitative genetics, but have not yet been used practically in cotton breeding because they are difficult to identify in cotton. To be useful in breeding we must be able to identify SNPs between different cotton varieties (varietal SNPs) and distinguish them from SNPs that are just differences between the two sub-genomes (Sub-genome SNPs) of this tetraploid species. Next-generation sequencing is now facilitating genome-wide SNP discovery in many crops, including cotton. We have used RNA short-read sequencing and complexity reduced genome sequencing to identify SNPs that will be useful for breeding. Based on the rationale that a varietal-SNP can be more confidently called when it is flanked by a close sub-genome-specific SNP, a bioinformatics pipeline has been developed that reliably identifies varietal SNPs in cotton. We have identified 25,885 varietal-SNPs among 18 upland varieties. Validation of these SNPs by various approaches has proven to be high. A public cotton consortium SNP Chip is planned with ~ 100,000 SNPs, many from the CSIRO program, that should make genotyping cotton varieties easy and more cost effective. The potential applications of these SNPs and genotyping platforms in cotton genetics and breeding will be discussed.

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Viruses, vectors and endosymbionts: exploring interactions for the control of cotton leaf curl disease

[1]**Sharon van Brunschot** [1]James Hereward [2]Cherie Gambley [3]Paul De Barro [1]Gimme Walter

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Stream: *Pest Management* **Poster**

Cotton leaf curl disease (CLCuD) presents a major biosecurity threat to the Australian cotton industry because it can decimate production. The disease is caused by a complex of one or more begomoviruses, and is spread by the whitefly (Bemisia tabaci). We currently have no knowledge of the ability of the whiteflies in Australian cotton to transmit viruses of the CLCuD complex. Also, a significant knowledge gap exists in our understanding of the complex interactions that occur between whiteflies and microbes. Microbial endosymbionts, the bacteria that live within the body or cells of another organism, are important (and often critical) to the biology of many insects. They can provide essential nutrients to their insect host, influence food digestion, sex ratios, reproduction and survival, and may even influence insecticide resistance. Importantly, recent studies have shown that endosymbionts likely play a key role in plant virus transmission. This new CRDC funded project will investigate the capacity of the whiteflies present in Australian cotton to transmit viruses of the CLCuD complex, the diversity of endosymbionts in Australian whiteflies and their influence on key biological characteristics on their hosts, and the development of diagnostic tools to support the industry's preparedness to deal with this biosecurity threat.

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Root growth of cotton under monoculture and in cotton and corn rotations

Camille Coleman[1,] Nilantha R. Hulugalle[2,] and Daniel K.Y. Tan[1]

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Stream: *Agronomy and Soils* **Poster**

The aim of this research was to estimate the potential contribution by cotton roots to soil carbon stocks by sowing a corn-cotton rotation in combination with either maximum or minimum tillage in comparison to that contributed by cotton-cotton and cotton-wheat rotations. The field experiment was conducted in Narrabri NSW, and consisted of six treatments in a split plot design with four replicates. The main plot treatments were the historical treatments (cotton-cotton sown after either minimum or maximum tillage, and cotton-wheat sown after minimum tillage) and the subplots were either a control (historical treatments, viz. cotton or fallow) or corn during the 2011-12 summer season. Cotton root growth during the 2012-13 season was measured with a minirhizotron and core break method. Above-ground vegetative growth was measured by plant mapping and dry matter sampling at frequent intervals. Cotton vegetative growth and potential carbon input by cotton roots were increased by including corn in rotation (cotton-corn-cotton) relative to historical cotton rotations. Additionally, the application of minimum tillage rotations showed a general trend of higher root carbon contribution than maximum tillage rotations. Cotton grown after corn in minimum tillage operations may have benefited from increased water availability, soil structure and better soil health due to corn providing increased amounts of organic matter in the top layers of soil, and potential improvements to soil porosity and structure due to the natural high root mass of corn.

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Better management of Bt-cotton refuges

Dominic Cross[1,2], Mary Whitehouse[2], Sharon Downes[2], and Sarah Mansfield[1]

[1]University of Sydney, [2]CSIRO Ecosystem Sciences

Stream: *Pest Management* **Poster**

The implementation of genetically modified *Bacillus thuringiensis* (Bt) cotton has reduced the use of chemicals by suppressing *Helicoverpa armigera* and *H. punctigera* pest populations. This results in selection for resistance to Bt since pests tolerant to Bt survive and convey their resistant genes to the next generation. To maintain susceptibility to Bt in pest populations, refuges of unsprayed non-Bt cotton or pigeon pea are planted with Bt cotton so that susceptible populations dilute any acquired resistance, delaying the onset of widespread Bt resistance. Glasshouse and field experiments were undertaken to determine a management strategy for maximum production of Bt-susceptible *Helicoverpa spp.* moths from refuges. Cotton and pigeon pea plants grown with limited access to water are poor hosts for *H. armigera* larvae, adding nitrogen under these watering conditions had no significant effect on improving survival rates. In cotton plants where water was not a limiting factor, adding nitrogen significantly improved survival rates of larvae, adding nitrogen in excess does not increase survival. A moderate amount of watering has a significantly higher survival rate than on plants which were watered to saturation. Survival of Helicoverpa eggs is higher in cotton, while survival of larvae is higher in pigeon pea, and cotton produced vastly fewer total moths than pigeon pea. The number of moths produced increases with an increase in stacking density to a maximum of 3 moths per metre. The average mortality at the pupal stage is approximately 50% - Heteropelma scaposum accounts for 33% of parasitism, tachinids 65%.

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The effects of honeydew on photosynthesis in cotton

Simone C. Heimoana[1,] Lewis J. Wilson[1,] Doug L. George[2] and Greg A. Constable[1]

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Stream: *Pest Management* **Poster**

Honeydew is excreted by aphids as a by-product of feeding. Its build-up on cotton leaves may block stomata and thereby reduce photosynthesis. We measured the effect of natural honeydew in the field and found it to significantly reduce photosynthesis by up to 41%, however, the effect disappeared soon after honeydew was washed off. We also assessed the physical effect of honeydew - without the associated effect of aphid feeding – by spraying artificial honeydew onto leaves. Photosynthesis and stomatal conductance on sprayed leaves were reduced by an average of 18 % and were affected by the coverage and thickness of the applied honeydew. Thicker layers of artificial honeydew reduced photosynthesis and conductance by 30 % and 36 %, respectively. Leaves did not always recover when artificial honeydew was washed off, indicating that it may have been washed off incompletely or that honeydew may have been lodged in the sub-stomatal cavity. In the field, sooty mould fungi and dust particles adhering to the sticky leaf surface could additionally reduce photosynthesis by shading out light. We tested this by applying dust to honeydew which further reduced photosynthesis by blocking solar radiation from reaching the leaf surface. Application of honeydew to the lower leaf surface also reduced photosynthesis suggesting that the primary effect of honeydew was via blockage of stomata, as in this situation reduction in light reaching the leaf surface could not occur.

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Soil fauna under continuous cotton and a cotton-wheat-vetch rotation

Viliami Heimoana and Nilantha Hulugalle

New South Wales Department of Primary Industries,

Stream: *Agronomy and Soils* **Poster**

Soil fauna influence litter and organic matter decomposition in soils and thus, have an important role in ecosystem productivity. They can also be used as bioindicators for monitoring changes in soil health. The objective of this study was to identify the soil fauna present and their abundance under two cropping systems (T2, cotton-winter fallow-cotton and T4, cotton-wheat-summer fallow-vetch-cotton; wheat stubble retained as standing stubble) in a long-term experiment at the Australian Cotton Research Institute. Insects were collected in pitfall traps at on 8 occasions between 7th October 2011 and 22nd April 2012. Pitfall traps were set in 3 clusters of 20 for each treatment. The mean numbers of soil fauna species trapped over the sampling period for the two cropping system varied significantly. There were significantly higher numbers of silken fungus beetle, antlike flower beetle, earwigs, rove beetles, thrips and wasp in T2 relative to T4, but the reverse occurred with respect to ants, aphids, millipedes, weevils and flies. There were generally more insects during summer than winter, and insect numbers increased over the season. Early-season arthropods consisted mainly of beetles followed by ants, wasps, thrips and mosquitoes. The warmer conditions during spring and summer favoured arthropods build-up and, thus, total numbers of individual species increased in both treatments. Further work will be needed to confirm and specify the abundance of the soil fauna present and their importance to the structure and quality of the soil.

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Spatial prediction of exchangeable sodium percentage at multiple depths using electromagnetic inversion modeling.

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University of NSW

Stream: *Agronomy and Soils* **Poster**

High levels of exchangeable sodium in the semi-arid regions of the world can cause surface crusting and structural instability. In order to manage such constraints with gypsum and lime, mapping its spatial distribution is necessary. Whilst geostatistical techniques, such as ordinary, co- and 3-d kriging have been used they have been criticized because they are unable to consider knowledge related to distribution, processes and factors of soil formation. Hence, digital soil mapping methods, which couple remote and/or proximally sensed data with soil information, are increasingly becoming useful because they provide high resolution ancillary data. In this paper we first inverted the electrical conductivity (ECa measured with EM34) of DUALEM-421 data collected along a single transect and generated a 2-dimensional electromagnetic conductivity image (EMCI). The estimates of electrical conductivity at 0.30 m depth increments to a depth of 1.5 m were related to measured soil ESP. The results of the inversion were compared with various possible coil array configurations of the DUALEM-421 to determine a suitable set of data. The use of the DUALEM-421 was found to be optimal ($r2 = 0.70$) and the calibration generated was used to estimate ESP along adjacent transects where we similarly generated EMCI. Using this approach we estimated ESP at various depths across a clay plain and an associated prior stream channel. We concluded that the collection of additional transects of DUALEM data as well as the use of a quasi-3d inversion modeling approach would improve the prediction of ESP.

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Assessment of fungal biopesticides for the control of *Creontiades spp.* in Australian broadacre crops

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Monsanto Australia, 2 QUT, 3 Qld DAFF

Stream: *Pest Management* **Poster**

Sucking pests have emerged as major pests in agricultural crops in Australia due to the reduction in chemical usage with the adoption of Integrated Pest Management (IPM), including the wide-scale use of microbial insecticides against *Helicoverpa spp.* (Lepidoptera: Noctuidae), and Bollgard II® cotton. No biopesticides for sucking pests are currently registered in Australia; however entomopathogenic fungi have potential to be developed into biopesticides. Isolates from the species *Metarhizium anisopliae* (Metschnikoff) and *Beauveria bassiana* (Balsamo) Vuillemin (Hypocreales: Clavicipitaceae) were selected to assess for pathogenicity and virulence against green vegetable bug in the laboratory. Four Australian isolates showed potential, achieving 90% or greater mortality in five days. We investigated the efficacy native isolates of *B. bassiana* and *M. anisopliae* we identified in the laboratory, against mirids in the field. The most effective field rate was 1 x 1013/Ha; higher rates (5 x 1013/Ha) of the *M. anisopliae* isolate had an impact on natural enemies. At the lower rate there was minimal impact on natural enemies. We used intensive sampling to develop a model of mirid population structure and development to identify potential windows for control using biopesticides. Intensive sampling was conducted in soybeans, cotton and mungbeans at regular intervals through the crop development from emergence to early reproductive stages. The results showed that mirids immigrate into crops and start breeding from vegetative stages 2 or 3 in mungbeans and can reach threshold prior to flowering.

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Quantifying the insect pest control services provided by insectivorous birds, microbats and beneficial insects on dryland cotton farms.

Heidi Kolkert, Nick Reid, Rhiannon Smith and Romina Radar

University of New England

Stream: *Pest Management* **Poster**

Natural pest control research on Australian cotton farms has largely focused on the services provided by beneficial invertebrates (e.g. predators and parasitoids). Although birds and bats are also known to occur on cotton farms, evidence supporting their biological and economic contribution to natural pest control in cotton crops is scarce. As such, we don't know what proportion of natural pest control services can be attributed to birds, microbats and beneficial invertebrates (BBIs). Based on other studies, the pest control services vertebrates provide is likely to be worth millions of dollars annually. My research will be conducted in cotton growing districts within the Border Rivers-Gwydir Catchment in northern NSW. The aim of this project is to investigate how the amount of vegetation in a landscape and the phenology of cotton, influences the diet preferences of predators and hence, the proportion of natural pest control services provided by vertebrates vs beneficial invertebrates. This research will guide NRM decisions on how to best manage BBI communities and maintain the ecosystem processes they support within agricultural land.

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Seed treatment trials - Why they are important

Peter A Lonergan, Karen A Kirkby, Beth R Cooper and Sharlene E Roser

NSW DPI

Stream: *Pest Management* **Poster**

Each year NSW DPI evaluates the effectiveness of seed treatment fungicides and combinations against seedling disease. The industry standard fungicide seed treatment for cotton for many years was a mixture of Terraclor® (Quintozene-PCNB) (active against Rhizoctonia) and Metalaxyl-M (Apron®) (active against Pythium spp.). Following the release of Dynasty® a new fungicide seed treatment in 2005/2006 from Syngenta®, registered to protect seeds, roots and emerging seedlings. Dynasty® replaced the historical industry standard. Metalaxyl-M remains a component of Dynasty®. PCNB was included in the 2010/2011, 2011/2012 and 2012/2013 seed treatment trials as a measure of Rhizoctonia pressure.

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Host plant resistance to twospotted spider mites in diploid cotton (*Gossypium arboreum* L)

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Stream: *Pest Management* **Poster**

The twospotted spider mite (*Tetranychus urticae* Koch) is capable of dramatically reducing the yield of cotton crops and is often difficult and expensive to control. We previously found novel germplasm with host plant resistance to spider mites in diploid cotton, *G. arboreum* (BM13H) by field screening experiments. Life history study indicated mites reared on BM13H (mite-resistant genotype) had longer immature development times, lower immature survival and reduced adult fecundity than Sicot 71 (mite-susceptible cultivar). The contribution to mite resistance of constitutive resistance mechanisms was much greater than induced responses. The effect of morphological constitutive defences was minor, implicating biochemical defences as the major mite-resistance mechanism. Foliar application of jasmonic acid (JA) and methyl jasmonate (MeJA) reduced the mite population and leaf damage but application of other potential elicitors, salicylic acid (SA) and methyl salicylate (MeSA) did not. The concentration of JA and SA in leaf tissues of induced and non induced Sicot 71 and BM13H were quantified by liquid chromatography tandem mass spectrometry (LC-MS/MS). The JA content was constitutively higher in BM13H than Sicot 71 and also highly induced by mite-infestation in BM13H but not in Sicot 71. SA, however, was not significantly induced in either BM13H or Sicot 71. The expression levels of JA related genes, LOX, AOS and OPR were induced in mite-infested BM13H. Therefore, JA and MeJA are implicated as key biochemical components in both the constitutive and induced defence responses in BM13H

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Investigating the cotton (*Gossypium sp.*) epigenome for fibre quality improvement

Kenji Osabe, Jenny D. Clement, Danny J. Llewellyn, Jean E. Finnegan and Iain W. Wilson

CSIRO Plant Industry

Stream: *Breeding* **Poster**

Cotton (*Gossypium hirsutum*) is an allotetraploid that is challenged by a relatively low level of DNA polymorphism within current germplasm sources. Epigenetic regulation, which mediates changes in gene expression that are not caused by changes in DNA sequence, can create an additional layer of phenotypic diversity on top of genetic diversity. Recent studies have shown that epigenetic mechanisms can be involved in stable inheritance of agronomically important traits in cultivated plants. Cotton fibres are single-celled seed trichomes that grow on the outer integument of the ovule and have been selected for high strength, length, fineness, and uniformity through phenotypic selection in breeding programs. The involvement of epigenetic mechanisms in determining these fibre characteristics is yet to be explored, but there is evidence of epigenetic regulation of leaf trichome density in plants. Our study investigates the importance of epigenetic regulation of fibre quality and development in cotton by 1) comparing epigenetic diversity to the genetic diversity of cultivars with different fibre quality using methylation-sensitive amplified polymorphism analysis, 2) assessing changes of the epigenome between different tissues of cotton by HPLC, and 3) investigate the phenotypic (fibre) changes caused by disrupting the cotton epigenome using a methylation inhibitor (Zebularine). The results of this work provide a preliminary understanding of the extent of DNA methylation levels and diversity in cotton and its possible involvement in fibre quality.

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Cotton industry adaptation to extreme weather and climate change

Yui Osanai[1], David Tissue[1], Ian Anderson[1], Michael Braunack[2], Michael Bange[2], Linh Nguyen[1], Brajesh Singh[1]

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Stream: *Agronomy and Soils* **Poster**

The projected changes in atmospheric concentration of carbon dioxide ([CO_2]), global mean temperature are some of the key issues concerning the sustainability of agricultural production. Superimposed on these are predicted changes in the frequency and severity of extreme weather events such as drought and flooding that may impact crop productivity directly or indirectly through changes in soil fertility and function. Yet, the impacts of these extreme weather events on crop productivity under future climate conditions are not currently well known. Therefore, this project will examine the impacts of extreme weather events (flooding and prolonged drought) on soil fertility and subsequent consequences for cotton productivity under current and future climatic conditions (elevated [CO_2] and temperature) using both in-field and glasshouse experiments. In the first six months of our project, our glasshouse experiments have demonstrated that cotton growth was strongly and positively responsive to elevated temperature (independent of elevated [CO_2]) with 220% increase in plant height and 60% increase in the number of nodes. Cotton growth was also positively responsive to elevated [CO_2] with 109% increase in height and 28% increase in the number of nodes, however this was only observed at ambient temperature. In elevated temperature, plants grown under elevated [CO_2] had higher photosynthetic rates and lower stomatal conductance than plants grown under ambient [CO_2]. We are currently analysing data on the role of soil fertility and function under these climatic conditions with the expectation that it will be central to understanding the long-term effect of climate change and extreme weather on cotton productivity, and thus the resilience of the cotton industry in the future.

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Soil microbial solutions for improved cotton crop establishment

Lily Pereg and Sarah Cooper

University of New England

Stream: *Agronomy and Soils* **Poster**

Cotton seedling-disease complexes reduce crop establishment and lead to yield loss. The period from seed germination to the establishment of cotton seedling is a critical stage in plant development. Up until the development of two to four leaves the plant is particularly susceptible to soil-borne diseases. The main aim of this project is to sustainably increase the success of crop establishment, improve plant nutrition and reduce the impact of soil-borne diseases in cotton growing systems. Every soil has potential to promote plant growth, with the most important players being the soil microbial communities. Some soil microbes recycle nutrients, converting N, P and C into forms available for plants. Others may suppress disease, secrete plant growth hormones, enhance stress tolerance, improve water retention in the rhizosphere and more. Plant growth promoting microbes have been employed worldwide in different crop production systems with varying degree of success. Here, we attempt to increase the degree of success by using indigenous PGP microbes isolated from local cotton soils for promoting seedling growth and enhancing crop establishment in Australian cotton. Certain crop production practices suppress the microbial natural plant growth promotion ability, e.g. nitrogen fixation is suppressed by application of chemical supplements of N, whereas removal of nitrogen by denitrification may be enhanced by such conditions. We use modern molecular techniques to analyse the soil potential for nitrogen fixation and N retention and seek ways to enhance this natural process by managing the amount and form of N applied to the soil.

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The role and effectiveness of refuge crops on commercial cotton farms.

William Tan[1] and Mary Whitehouse[2]

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Stream: *Pest Management* **Poster**

The current view is that pigeon pea is a better refuge crop than unsprayed, non transgenic-cotton on Bt-cotton farms. This is because pigeon pea is twice as attractive and productive as cotton. Consequently, farmers are only to devote 5% of the area of their Bt crop to pigeon pea refuges as opposed to 10% of the Bt cotton area to non-Bt cotton refuges. This, however, is only effective when the pigeon pea refuge is looked after and able to reach its flowering potential. On commercial cotton farms where, cotton and pigeon pea refuges, are at different lifecycles stages, and experience different amounts of care and different climates, the difference may not be so pronounced. The aim of this experiment was to correlate attractiveness, productivity and plant parameters within and between cotton and pigeon pea refuges grown on commercial crops. This was calculated using egg count to quantify attractiveness, and pupae digs to quantify productivity, while trying to identify plant parameters which could predict attractiveness and productivity. The results were that all pigeon pea in our sample flowered and were twice as attractive and productive as the cotton refuges, while the larvae developing in cotton trended to have a higher survival rate.

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Quality of drainage water under irrigated cotton in the lower Namoi valley

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Stream: *Agronomy and Soils* **Poster**

Comparative research on the effects of soil and crop management practices in cotton farming systems on the quality of drainage water is limited. The objective of this study was to quantify drainage water quality in the subsoil (0.6 m, 0.9 m, 1.2 m) of sodic and non-sodic Vertosols under selected cotton cropping systems. The experimental sites were located at the Australian Cotton Research Institute (ACRI) near Narrabri and on two commercial cotton farms near Wee Waa and Merah North in northern New South Wales. A cotton-wheat rotation was sown at Wee Waa and ACRI; wheat stubble was incorporated in the former and retained as in situ mulch in the latter. At Merah North, there were three cropping sequences; viz. continuous cotton, cotton-wheat, and cotton-dolichos sown between 1993 and 2000 in adjacent plots with identical land management histories. Drainage water was sampled with 50-mm diameter ceramic-cup samplers from depths of 0.6 m, 0.9 m and 1.2 m in six sites in each plot and irrigation water from the head ditch after irrigation from October to February during the cotton-growing seasons of 2000-2001 and 2002-2003. Extracted water was analysed for pHw, ECw, Cl-, NO3-N, K^+, Ca^+, Mg^+ and Na^+. Salt and nutrient concentrations in drainage water varied among sites, and reflected variations in soil properties, fallow length since the preceding crop, fallow rainfall and irrigation water quality. Salinity and SAR of drainage water was many times higher than that of irrigation water. Salinisation and sodification of shallow groundwater reserves under irrigated cotton is, therefore, possible. Salinisation and sodification of the root zone may occur even when irrigated with water of a quality that is generally accepted as being ‘reasonable’.

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