Australian Government
Cotton Research and Development Corporation

# TRAVEL, CONFERENCE or SCIENTIFIC EXCHANGE REPORT 2016

## *Part 1 - Summary Details*

**Please use your TAB key to complete Parts 1 & 2.**

**CRDC Project Number:**

## Project Title: APS Annual Meeting and Lubbock visit

**Project Commencement Date:** 3/08/2017 **Project Completion Date:** 26/08/2017

**CRDC Research Program:** 2 Industry

## *Part 2 – Contact Details*


**Administrator:** Michelle Smith
**Organisation:** NSW DPI
**Postal Address:** Locked Bag 21, Orange, NSW, 2800
**Ph:** 0263913658 **Fax:** **E-mail:** michelle.smith@dpi.nsw.gov.au

**Principal Researcher:** Dr Karen Kirkby
**Organisation:** NSW DPI
**Postal Address:** Locked Bag 1000, Narrabri, NSW, 2390
**Ph:** 0267992454 **Fax:** **E-mail:** karen.kirkby@dpi.nsw.gov.au

**Supervisor:** Leigh Pilkington
**Organisation:** NSW DPI
**Postal Address:** Locked Bag 26, Gosford, NSW, 2250
**Ph:** 0243481953 **Fax:** **E-mail:** leigh.pilkington@dpi.nsw.gov.au


**Signature of Research Provider Representative:** _____

**Date Submitted:** _____

*Part 3 – Travel, Conference or Scientific Exchange Report*

**1. A brief description of the purpose of the travel**.

I (Dr Karen Kirkby) received an invitation from Dr Jason Woodward from Texas Tech University and Dr Terry Wheeler from Texas A&M AgriLife Research & Extension Center at Lubbock to visit the laboratories at the Lubbock Center and visit production fields throughout the High Plains as well as to learn their isolation techniques used to quantify *Verticillium dahliae* from soil following the APS Meeting in San Antonio. This travel would allow Dr Kirkby to attend and present (should her abstract be selected), the APS Annual Meeting in San Antonio from the 5th-9th August followed by a two week visit in Lubbock between 10th and 26th August, 2017.

The meeting titled Changing landscapes of Plant Pathology will hold field trips, APS Connects – Networking events as well as workshops. The workshop titled Morphological ID of phytopathogenic fungi held on Saturday 5th 9am – 4pm is particularly relevant along with the special session on the re-emergence of bacterial blight.

My abstract submission titled "Genetic and morphological characterisation of *Verticillium dahliae* collected from cotton crops throughout NSW, Australia" has been submitted. Presenting this research to an international audience will be used to demonstrate the difference characteristics of Australian *Verticillium dahliae* isolates in comparison to those published in literature to date. It will also outline the successful international collaboration between NSW DPI and Spanish collaborators. Attending the workshop titled "Morphological ID of Phytopathogenic fungi" will provide the opportunity increase diagnostic skills and learn techniques used to identify pathogens of interest using morphological characteristics.

Extending the trip to include a two week visit with Dr Jason Woodward and Dr Terry Wheeler will have direct benefits to my current research project "Managing Verticillium risk for Cotton". Both Jason and Terry developed the risk matrix for Verticillium and inoculum levels currently used in the USA. The opportunity to work with these researchers will enhance my understanding and skills surrounding the development of a similar risk matrix for Australian cotton industry and these relationships will remain invaluable progressing forward.

**2. What were the:**

**a) major findings and outcomes**

A particular highlight was the opportunity to work collaboratively with Dr Woodward on soil isolation techniques for isolating *Verticillium dahliae* from soil. This project will involve continued collaborative work over the coming months. The results of these experiments on isolation techniques will be presented at the Beltwide conference in 2018 with co-authorship between USA and NSW DPI. This research is particularly beneficial to the current project that I am leading and will enhance the development of the diagnostic and quantification assay currently being developed in Australia. The visit provided an opportunity to strengthen relationship between myself and Texas pathologists Dr Terry Wheeler and Dr Jason Woodward.

**b) other highlights**

Dr Woodward kindly hosted me the two weeks I was in Lubbock. His research project paid for my meals and all other expenses associated with the travel through the High Plains while I was there. I am extremely grateful as this meant the trip was very economical for both CRDC and the NPBDN who co funded my scientific exchange.

We are currently discussing the possibility of reciprocating a visit by Dr Woodward and a couple of Texas Tech university students visiting the Australian Cotton Research Institute in Narrabri and surrounding cotton growing regions for approximately two weeks in February 2018.

**3. Detail the persons and institutions visited, giving full title, position details, location, duration of visit and purpose of visit to these people/places.**

**APS Annual Meeting update**

APS Annual Meeting 2017 was held at the Convention Center, San Antonio, Texas 5- 9th August. The focus of the conference was Changing Landscapes of Plant Pathology and had sessions that focused on integrated disease management, disease control and resistance issues, biological control, assessing the value of disease control in changing landscapes. The conference is structured into five days. The first day featured pre conference workshops. The remaining four days featured breakout sessions and general sessions followed

by several committee meetings in the evening. There was a networking reception on the first day and networking breaks in the Exhibit Hall throughout the conference. The Exhibit Hall was held onsite during the Conference. All networking breaks were in the Exhibit Hall, allowing for multiple opportunities to visit with companies and investigate new products and services.

The APS Annual Meeting is the premier international pathology conference dedicated to providing the latest research results and best practices for managing all crop pathology issues. The meeting attracts between 1500 a 2000 international extension and pathologists. The networking opportunities appealed to me, as did the opportunity to learn from the technical sessions and special workshops. I was particularly interested in sessions on Morphological ID of phytopathogens and the session on re-emergence of bacterial blight of cotton. In addition to the special sessions, the chance to network with other colleagues in similar situations was an extremely valuable experience. I was also able to interact with other poster presenters and those with a particular interested in Verticillium research. The opportunity to research new solutions and discuss current technologies with leading researchers was very worthwhile and a cost-saving. During the conference, I was able to attend numerous sessions. I was able to focus on topics that directly relate to my position and find solutions for ongoing projects.

I was very pleased to have the opportunity to attend the APS Annual Meeting in San Antonio and felt it was well worth the registration fee and travel expenses. I learned new skills, found solutions and best practice strategies that can be implemented into my current research project. The APS Annual Meeting was very organised and the speakers provided research updates on the subject matter at hand, making the information extremely valuable. Presenting a poster in The Exhibit Hall provided a friendly, informative place to meet with fellow researchers, poster presenters and attendees.

**Scientific research exchange update**

I was extremely fortunate to receive an invitation to spend two weeks working with leading pathologists Dr Jason Woodward and Dr Terry Wheeler at the Texas A& M AgriLife Research & Extension Centre in Lubbock, Texas. During the two week visit I worked in the field pathology laboratory gaining skills in identifying pathogens in cotton and peanut crops, vegetable crops and weeds. I witnessed the symptoms associated with *Alternaria macrospora* in cotton crops. In addition, I gained valuable experience that couldn't be obtained anywhere else. I learned about individual characteristics to look for when detecting and diagnosing exotic strains of Verticillium and Fusarium wilt, bacterial blight alone and with *Psuedomonas syringae* as well as South Western rust. I was taught new diagnostic techniques that will directly benefit my project through efficiency gains and accuracy. I had unrestricted access to industry experts who provided tips and useful information for my particular dilemmas and work projects. I am grateful to have had the opportunity to travel extensively throughout the High Plains of Texas, visiting many farms, speaking with extension specialists, students, growers and county agents. Collectively everyone gave their time freely and was willing to share their knowledge and experience with me. For this I am most grateful.

**4. a) Are there any potential areas worth following up as a result of the travel?**

Areas to be followed up on include:

- Continue to test the dry and wet plate isolation technique used by USA and Australian researchers and combine the data into a co-authored presentation at the Beltwide in 2018.
- Formalise the collaboration projects discussed in the USA. We are currently discussing reciprocating a visit for Dr Woodward and a couple of Texas Tech university students to visit the Australian Cotton Research Institute in Narrabri and surrounding cotton growing regions for approximately two weeks in February 2018. Funding opportunities will be investigated.
- Instigate teleconferences held between all pathologists and CottonInfo team members every two weeks throughout the cotton growing season. This would benefit the industry immensely and allow opportunities for further research and collaboration to be discussed as well as providing direct communication between pathologists and extension staff.

**b) Any relevance or possible impact on the Australian Cotton Industry?**

- Increased diagnostic capability – first-hand experience diagnosing defoliating strains of Verticillium wilt and bacterial blight in cotton. This will increase the NSW DPI's diagnostic capabilities and increasing the cotton industry's preparedness for exotic incursions.

- Increased diagnostic capacity gained through participation in the morphological identification of phytopathogenic fungi workshop held at the APS annual meeting in San Antonio.
- Strengthened relationships with leading international researchers with the potential for collaboration – currently there are several research experiments being discussed.

**5. How do you intend to share the knowledge you have gained with other people in the cotton industry?**

I presented a three minute presentation titled Verticillium wilt - An American Perspective at the AACS conference in Canberra on the 6th September. I will share the knowledge and experience I have gained through personal conversations with NSW and QLD pathology staff, CottonInfo, CRDC, cotton researchers, agronomists and growers. I will write an article to be circulated within the industry to CottonInfo outlining my key learnings from the exchange. A travel report has been completed for the joint travel funders: Cotton Research and Development Corporation and the National Plant Biosecurity Diagnostic Network.

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NSW DPI, CRDC and NPBDN funded scientific exchange to Texas, USA update

Dr Karen Kirkby and Dr Jason Woodward

An invitation was extended to Dr Karen Kirkby from Dr Jason Woodward from Texas Tech University and Dr Terry Wheeler from Texas A&M AgriLife Research & Extension Center at Lubbock to visit their laboratories and visit production fields throughout the far west and High Plains, Texas.

**Extension meetings**

Whilst in Lubbock Karen attended two Plains cotton grower meetings which are held every two weeks in Lubbock. Pathologists, extension county agents and growers participated as well as teleconferencing for those who could not attend in person. Disease, weed and pest issues were discussed from each regional area and potential solutions discussed. This open, transparent collaboration was very informative and productive. Karen would like to see if the Australian cotton industry could implement a similar approach with regular teleconference meetings between pathologists, CottonInfo representatives and consultants held throughout the growing season.

**Soil isolation techniques used to enumerate *V. dahliae* in soil**

Karen took the opportunity to commence collaborative research whilst in Lubbock comparing soil isolation techniques by USA researchers (Figure 1) and the method she uses in Australia for isolating *Verticillium dahliae* from soil. The results of these laboratory experiments, conducted simultaneously in the USA and Australia will be presented at the Beltwide conference in 2018 with co-authorship between USA and NSW DPI. This research is particularly beneficial to the current project that Karen is leading and will enhance the development of the diagnostic and quantification assay currently being developed in Australia. Growers in the USA use inoculum thresholds to assist them in planning which fields to plant cotton or rotate based on risk levels. This is why the NSW DPI pathology team are currently developing a fast and accurate assay to determine inoculum levels as well as creating a risk matrix that is applicable to the Australian cotton industry.

Figure 1. Dr Jason Woodward demonstrating the wet dilution plate technique used in USA for enumerating Verticillium inoculum in soil.

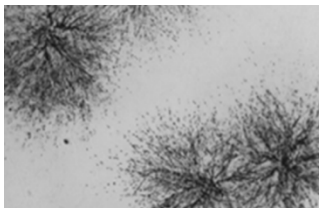

Figure 2. Colonies of *V. dahliae* on selective media

The time spent with Jason and Terry strengthened international relationships with direct benefits to Karen's current research project "Managing Verticillium risk for Cotton". Both Jason and Terry developed the risk matrix for Verticillium and inoculum levels currently used in the USA, which meant Karen was able to increase her understanding and skills surrounding the development of a similar risk matrix for Australian cotton industry and these relationships will remain invaluable progressing forward.

**Defoliating Verticillium wilt**

Karen extended her first-hand experience detecting and diagnosing defoliating Verticillium wilt in cotton and peanut crops and Cockle burr. America has both defoliating (Figure 2) and non-defoliating strains of *Verticillium dahliae;* however defoliating verticillium is predominant in back to back cotton fields.

Figure 2. Symptoms of defoliating *Verticillium dahliae* in cotton with typical mottling and necrotic tissue on leaves.

Fields with a lot of vegetable production tend to have more non-defoliating, particularly if they are in rotation with cotton such as in California. Weeds are also a problem, such as cockle burr being an alternative host for the pathogen (Figure 3).

Figure 3. Cockle burr is an alternative host for the pathogen V*erticillium dahliae*

Verticillium wilt occurs in light and heavy soils, but generally is a worse problem in heavier soils. Disease can also be severe on sandy soils, given enough water. Verticillium wilt is found to some degree in approximately 70% of the irrigated fields.

Typically, the first symptoms are seen at full bloom, unless conditions have been hot and dry. The most conducive weather for disease development is when daytime temperatures are around 26ºC and night time temperatures are 16ºC or below, accompanied with rainfall and cloudy conditions. Yield losses can be severe, where the worst varieties yield about 50% of the best varieties. When Verticillium wilt is severe, losses of one bale per acre in the best varieties are not uncommon.

Growers use different irrigation methods throughout Texas. Observational data suggests the severity of Verticillium wilt reduced when growers changed from furrow to pivot irrigation using sprinklers. The use of drop hoses led to further reductions. Fields with drip irrigation fields have considerably less Verticillium wilt, but the suitability of this method depends on soil type.

Yield losses due to Verticillium wilt vary by year; however, an estimated 37,700 bales were lost to the disease in 2015. Yield losses as high as 1 bale has been reported from recent studies. Management options include planting partially resistant varieties, regulating irrigation (especially late in the season), maintaining proper nutrition, controlling weeds and implementing preventative crop rotation schemes.

**Fusarium wilt (Race 4)**

Whilst in El Paso Karen observed for the first time, Fusarium wilt caused by *Fusarium oxysporum* f.sp. *vasinfectum* (Race 4) in Pima cotton. Particular care was taken to ensure the risk of moving the pathogen was minimised by wearing boot covers prior to entering infected fields (Figures 4). Jason went to great length to describe the symptoms to look for in diseased cotton plants (Figure 5) and they celebrated when Karen was able to detect and identify Race 4 infected plants (Figure 6). Infected plants when cut down the stem have typical browning in the centre of the stem and root (Figure 7).

Figure 4. Masters student Shelby Young, Jason Woodward and Karen Kirkby preparing to enter a wet field with Fusarium wilt (Race 4).

Figure 5. Jason Woodward describing the symptoms of Fusarium wilt (Race 4) to look for in cotton plants.

Figure 6. Two pathologists celebrating the ability to find and identify Fusarium wilt (Race 4) in a cotton field.

Figure 7. Characteristic stem symptoms of Fusarium wilt (Race 4) in cotton.

Fusarium wilt (Race 1) is the predominant race of FOV; however, the detection of Race 4 in 2017 will impact production in the states. Results from studies conducted in severely infested fields can lead to complete loses. Management is achieved mostly through the use of partially resistant varieties. Abundant information exists regarding the reaction of Upland varieties to FOV Race 1, but such information is limited for FOV Race 4.

**Bacterial blight**

Karen was shown bacterial blight in cotton caused by *Xanthomonas citri* pv. *malvacearum* known as Xcm (Figures 8 and 9). Bacterial blight was a major disease of cotton in the mid-1970s causing between 35 and 60% yield losses prior to acid delinting. Severe infection can cause quick defoliation and destroy an entire crop in days. Following the 1970s, the disease was supressed with the widespread adoption of resistant cultivars and acid delinting of seed.

Since 2015, there have been growing reports of bacterial blight in cotton varieties normally considered resistant with reported yield losses of up to 20%. At first it was thought there might be a new race, however, recent research has shown two types of bacteria (Xcm and *Pseudomonas syringae*) cooperating in the plants making some of the resistant cultivars susceptible to bacterial blight. Typical symptoms of dual infection include a characteristic yellow halo surrounding the bacterial blight infected areas (Figure 10).

Figure 8. Typical sunken water soaked lesions seen on cotton bolls infected with *Xanthomonas citri* pv. *malvacearum*.

Figure 9. Underside of leaf showing water soaked lesions and upper side of cotton leaves with characteristic angular shape lesions due to veins limiting bacterial movement.

Figure 10. Characteristic yellow halo surrounding the bacterial blight infected areas of the leaf.

Incidence and severity of Bacterial blight has increased substantially over the past few seasons. This is in part to producers planting susceptible varieties because of the herbicide traits required to manage weeds. Sporadic outbreaks of the disease routinely occur when warm, moist conditions are experienced prior to bloom. Planting a highly resistant variety is advised to manage the disease. Residue management and crop rotation may be used to deactivate inoculum if planting a susceptible variety. The bacterium is known to be seedborne, therefore, it is inadvisable to use seed produced in fields exhibiting symptoms on leaves or bolls.

**Southwestern cotton rust**
Karen had the opportunity to observe Southwestern cotton rust caused by *Puccinia cacabata*. This disease has a complex life cycle requiring two different host plants: grama grass and cotton to complete the life cycle. Spores that are produced on the grama grass germinate to produce airborne spores that cause infection on cotton. The spores produced on the cotton can only infect grama grass.

The first symptom on cotton is small yellow/brown lesions on the upper side of leaves (Figure 11 Left) that develop into bright orange/yellow aecia on the underside of leaves (Figure 11 Right), bracts, bolls and stems. Severe infection can cause defoliation and plant death.

Figure 11. (Left) Upper and lower side of cotton leaves infected with Southwestern rust.

Southwestern rust occurs only in far western production regions. While severe epidemics have been observed, the arid conditions experienced in the region seldom lead to significant losses being incurred. When environmental conditions favour disease, producers may opt to make preventative fungicide applications.

**Alternaria stem blight and leaf spot**
Karen observed large patches of dead and dying cotton plants caused by *Alternaria macrospora* (Figure 13). Alternaria leaf spot is a common cotton disease that is associated with late season development and is most severe when plants are deficient in potassium or under drought conditions.

Figure 13. A patch of dead plants caused by *Alternaria macrospora*.

On close inspection of infected plants, lesions can be seen on senescing leaves and bending of the terminal is typical (Figure 14).

Figure 14. Cotton plant with a bent terminal, a typical symptom of *Alternaria macrospora* infection.

Alternaria stem blight and Alternaria leaf spot only occur sporadically and seldom impact yield. Stem blight is capable of reducing lint yield and fibre quality substantially compared to healthy areas in the field, but seldom affects areas larger than 0.6 hectares. Premature defoliation can occur with leaf spot epidemics; however, such infections occur late in the season and do not warrant fungicide or nutritional applications.

Karen is grateful to have had the opportunity to travel extensively throughout the Far West and High Plains of Texas, visiting many farms, speaking with extension specialists, students, growers and county agents. Both Jason and Terry gave their time freely and were willing to share their knowledge and experience with her. Funding was provided by NSW DPI, Cotton Research and Development Corporation and National Plant Biosecurity Diagnostic Network.

TEXAS A&M AGRILIFE EXTENSION

**OFFICE OF JASON WOODWARD**

August 29, 2017

To Whom It May Concern:

This letter is to express my appreciation for authorizing Dr. Karen Kirkby to spend two weeks with our Cotton Research and Extension Team in Lubbock, Texas. Karen joined us following her attendance at the American Phytopathological Society (APS) meeting in San Antonio. Although Karen's primary crop responsibility is cotton diseases, she was very excited to experience diseases in different cropping systems. While returning from the conference we had an opportunity to visit a research vineyard operated by Texas Tech University and observe first hand several economically important grape diseases. Samples were collected and used to refine our diagnostic skills and capabilities. Numerous other samples were collected from vegetable, ornamental, horticultural and row crops.

There was also an opportunity for Karen to meet with and address a group of county Extension agents regarding her experiences conducting applied research and field surveys. Following that meeting we visited Far West Texas where we are addressing Fusarium wilt in cotton similar to what Karen has worked with in Australia. Conversations with Karen enlightened my colleagues and I about this disease. In return, Dr. Kirkby was introduced to Southwestern cotton rust, which is caused by a pathogen with a complicated lifecycle and is unique to west Texas. Karen was able to observe Bacterial blight of cotton in the field, as well as in the lab. Furthermore, she was able to experience and work with a novel bacterial pathogen capable of infecting cotton.

We took full advantage of the time required to travel to and from the locations visited, discussing at length collaborative projects involving Verticillium wilt and Black root rot. In fact, preliminary data was collected today in an experiment comparing methodologies enumerating inoculum densities of *Verticillium dahliae*, the causal agent of Verticillium wilt. Discussions are on going to replicate these studies and duplicate efforts in NSW in order to refine protocols used to determine soil populations of the fungus. We anticipate a joint presentation by Ms. Shelby Young, a graduate student in my program, at the Beltwide Cotton Conference in January 2018.

Dr. Kirkby's visit was extremely important and allowed us to discuss many aspects of disease management we have in common. I feel that this opportunity has set the foundation for these and many other research projects that will benefit cotton producers in both Texas (the United States) and NSW (Australia). While visiting Lubbock, my family and I hosted Karen in our home and we would be happy to do so again if the chance arises. Please feel free to contact me if you have any questions or would like any more details about our current or future collaborations.

Kindest regards,

Jason E. Woodward

Jason E. Woodward, Ph.D.
Extension Plant Pathologist
Texas A&M AgriLife Extension

**Texas A&M AgriLife Extension Service**
1102 East FM 1294
Lubbock, TX 79403

jewoodward@ag.tamu.edu
(806) 632-0762