2002 BELTWIDE COTTON CONFERENCES, ATLANTA, GA – JANUARY 8-12

THE AUSTRALIAN COTTON INDUSTRY RESPONSE TO THE FUSARIUM WILT PROBLEM

Stephen J. Allen
Cotton Seed Distributors Ltd.
Autralian Cotton Cooperative Research Centre
Narrabri, AUSTRALIA

Abstract

Fusarium wilt of cotton was first recognized in Australia in 1993 and has since become widespread and significant. The disease was quickly identified as a threat to productivity and the Australian cotton industry responded accordingly. This response included: the establishment of a centralized free diagnostic service; the appointment of an extension coordinator and the production of appropriate extension material; the promotion of the importance of farm hygiene to reduce the spread of the pathogen; the development of a seed production protocol; an investigation into the efficacy of fungicide treatments for seed disinfestation; the development of intensive breeding programs to identify and incorporate local or overseas sources of resistance; the development of an industry-wide protocol for describing and ranking the level of disease resistance in current commercial varieties; the implementation of a field research program to identify agronomic practices that would reduce disease incidence and/or severity; and the utilization of biotechnology to develop diagnostic tools and identify genetic markers and transgenic traits that might be of use to the breeding program. These research and extension efforts, though funded and directed from different sources, are coordinated by an Australian Cotton Cooperative Research Centre - Fusarium wilt research coordination committee (FUSCOM) that organizes annual workshops and field inspections.

Introduction

Fusarium wilt of cotton caused by *Fusarium oxysporum* fsp. *vasinfectum* was first recognized in cotton crops in Queensland in the 1992/1993 season (Kochman, 1995). Cotton growers have since indicated that they had noticed the disease as early as 1988. The disease was first observed in NSW in 1994. Fusarium wilt is now widespread in cotton production areas in southern Queensland and has been confirmed as present on 43 farms in NSW. The disease has not yet been observed in remote cotton production areas in the north of Queensland or the west and south of NSW or in the Lower Namoi valley of NSW.

There is considerable circumstantial evidence that the pathogen has been, and is being, dispersed in soil and crop residues being moved by flood waters or carried on farm machinery and vehicles.

Australian Cotton Industry Response

Diagnosis/Characterization

A centralized, free diagnostic service was established in Brisbane using expertise from a group that had had considerable experience working with *Fusarium oxysporum* fsp. *cubense*. Dr Natalie Moore of the Queensland Department of Primary Industries isolates the pathogen from stem samples and identifies the Vegetative Compatibility Grouping while Dr Suzy Bentley from the University of Queensland applies DNA amplification fingerprinting when appropriate. Samples are submitted by cotton growers, agronomists and extension officers. Such people are encouraged by the slogan. *"If in doubt – Check it out!"*

Two fungal genotypes have been identified and described as VCG 01111 and VCG 01112 (Davis et al., 1996; Bentley et al., 2000). These have been found to be distinctly different from those races that have been found in other cotton production areas of the world. In contrast with Fusarium wilt in the USA, the development of disease symptoms does not require the presence of nematodes under Australian conditions.

Extension

An Industry Development Officer (IDO), employed by the Queensland Department of Primary Industries and funded by the Cotton Research & Development Corporation, was assigned national responsibility for developing and circulating relevant information to growers, agronomists and contractors. This extension specialist has:

- organized numerous presentations at grower meetings and field days,
- compiled and used a mailing list of contractors servicing the industry,
- coordinated the production of 'Information Sheets' that have been sent to all growers
- surveyed growers, agronomists and consultants to determine attitudes and perceptions

Farm Hygiene
A farm hygiene policy has been developed under the slogan 'Come clean – Go clean' and many farms have installed wash-down pads to enable compliance. Contractors and agronomists etc. and their vehicles and machinery should be cleaned before leaving one farm so that they can arrive clean at the next farm they visit. Farm machinery should be cleaned after working in a field where disease is present before being moved to fields that are thought to be disease free. After testing a range of cleaning agents Moore and O'Neill (2000) were able to recommend a detergent based degreaser for disinfecting machinery to reduce the spread of Fusarium wilt.

Seed Production Protocol
The Australian Cotton Research and Development Corporation coordinated a meeting of cotton breeders and seed production companies to develop an industry-wide protocol for producing pathogen free seed. The protocol covers all stages of seed production from breeder's plots to commercial seed crops. Basic principles include:

- Seed production areas are located away from areas where the disease is known to occur.
- Seed production crops are inspected at least three times to ensure freedom from Fusarium wilt.
- Seed production fields are abandoned if Fusarium wilt is found elsewhere on the same farm.

The fact that Fusarium wilt has not been observed in one of the large central production areas and in the more isolated production areas would suggest that seed transmission has not been a factor in the spread of the disease in Australia to date.

Seed Disinfestation
The efficacy of fungicide seed treatments for the elimination of the pathogen from within infested seed was investigated as a precaution against the possibility of seed transmission. The fungicide metalaxyl, which is used on most planting seed in Australia, was found to provide complete suppression of seed borne *F. oxysporum* f.sp. *vasinfectum* when tested on seed collected from infected plants (Allen and Kochman, 2001).

In similar experiments over two seasons, with several collections of seed from infected plants, the viability of the pathogen within seed was found to decline to zero within ten months of picking, ginning and acid delinting (J.K. Kochman, *pers. comm*.).

Breeding Programs
The CSIRO and DeltaPine breeding programs in Australia have been expanded considerably in order to identify and improve the level of variety resistance to Fusarium wilt and to ensure that the resistance of a new transgenic variety is similar to that of the parent conventional variety. Current commercial varieties range from completely susceptible, where no plants survive to the end of the season, through to some resistance, where under very high disease pressure, only 35% of plants may survive to the end of the season.

Germplasm has been collected from various international sources and evaluated in Australia against Australian races of the pathogen. Various sources of resistance have been identified and are being utilized. Resistance has also been found in some of the diploid, native Australian species of *Gossypium*. Varieties regarded as resistant to Fusarium wilt in the USA appear to be quite susceptible to the disease under Australian conditions.

Many breeding lines are planted at both disease-free and heavily infested sites to enable screening for Fusarium wilt resistance. Selected lines are progressed using the seed collected from the plants at the disease-free site. This duplication of plots is necessary but inconvenient. Efforts are being made to identify genetic markers to simplify the screening process.

Resistance Ranking
In response to cotton grower requests an impartial 'Fusarium Resistance Ranking' system has been developed to indicate the relative resistance or susceptibility of commercial varieties from seed companies. The resistance ranking of a variety is expressed relative to that of a standard variety where the standard has a ranking of 100. The standard variety was chosen because it had the highest level of resistance prior to the commencement of breeding efforts to identify and introduce higher levels of resistance. The number of field comparisons used to determine the ranking is indicated in brackets and assessment is based on survival of plants to the end of the season. Thus a Fusarium resistance ranking of 130(9) indicates that the variety is 30% more resistant than the standard and that this ranking is based on the results of nine field comparisons. Similarly, a Fusarium resistance ranking of 78(4) indicates that the variety is 22% more susceptible than the standard based on the results of four field comparisons.

Agronomic Research

As discussed previously (Allen and Lonergan, 2000) significant effort has been directed into identifying practices that can be incorporated into an integrated disease management strategy for Fusarium wilt of cotton in Australia. Current field experiments are evaluating cultivation, fertilizer, soil fumigation, biocontrol, fungicide and induced resistance treatments as well as crop rotation options for minimizing disease incidence and severity.

Biotech Research

The research group at the Cooperative Research Centre for Tropical Plant Protection in Brisbane are developing DNA diagnostics for Fusarium wilt of cotton (Bentley et al., 2000). They are able to detect the pathogen and identify the race from DNA extracted from soil, seeds or plant stems. It is anticipated that these tools will enable detection of the pathogen in soil samples before the observation of symptoms on plants in the field.

There are several research groups evaluating a range of transgenic options for obtaining increased resistance to Fusarium wilt.

Research Coordination

The Australian Cotton Cooperative Research Centre is a non-incorporated joint venture between all research and extension providers and some industry bodies. It sponsors a 'Fusarium wilt research coordination committee' that has become known as 'FUSCOM'. The threefold objective of FUSCOM is to:

- encourage collaboration between the various research groups.
- develop an integrated disease management strategy for Fusarium wilt of cotton in Australia.
- ensure that the results of research activities are communicated quickly to growers.

This committee which includes growers, cotton consultants, researchers and representatives of funding bodies, organizes the annual Fusarium workshop and the inspection of field experiments when appropriate. FUSCOM has also been active in the production of extension publications and the development of the resistance ranking protocol.

References

Allen, S.J. and J.K. Kochman. 2001. Eliminating seed borne inoculum of Fusarium oxysporum fsp. vasinfectum in cotton. Proceedings of the Beltwide Cotton Conference Volume 1:139-140 (2001). National Cotton Council, Memphis, TN.

Allen, S.J. and P.A. Lonergan. 2000. Control strategies for Fusarium wilt of cotton in Australia. Proceedings of the Beltwide Cotton Conference Volume 1:136-138 (2000). National Cotton Council, Memphis, TN.

Bentley, S., Kochman, J.K., Moore, N.Y., Pattemore, J.A., Gulino, L. and W.T. O'Neill. 2000. DNA diagnostics for Fusarium wilt of cotton. Proceedings of the 10th Australian Cotton Conference, p455-461

Davis, R.D., Moore, N.Y.and J.K. Kochman. 1996. Characterisation of a population of Fusarium oxysporum fsp. vasinfectum causing wilt of cotton in Australia. Australian Journal of Agricultural Research 47:1143-56

Kochman, J.K. 1995. Fusarium wilt in cotton - a new record in Australia. Australasian Plant Pathology 24(1):74

Moore, N.Y.and W.T. O'Neill. 2000. Detergent based degreaser for disinfecting machinery to reduce the spread of Fusarium wilt of cotton. Australian Cotton CRC Cotton Information Sheet