CONTROL STRATEGIES FOR FUSARIUM WILT OF COTTON IN AUSTRALIA

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Abstract

Fusarium wilt of cotton has become a significant problem for Australian cotton growers since it was first observed in the 1992/93 season. Australian races of the pathogen are unique and nematodes are not involved in the etiology of the disease. Cotton breeding programs have produced some cultivars with a degree of resistance to the pathogen. Summer flooding provided good control of fusarium wilt at two sites and crop rotation treatments, the retention of crop residues on the surface, the use of systemic induced resistance and the adoption of better farm hygiene were identified as potential components of an integrated disease management strategy. The use of more effective seed treatment fungicides, solarisation, biofumigation and biocontrol treatments is being investigated.

Introduction

Fusarium wilt of cotton caused *by Fusarium oxysporum* f.sp *vasinfectum* was first observed in Australia during the 1992/93 season (Kochman et.al.,1996) and is now present in six of the ten production areas in eastern Australia. The disease is widespread in two of the six affected areas. Isolates of the pathogen have been characterized using vegetative compatibility grouping and DNA fingerprinting (Kochman et.al.,1996). Two distinct races have been identified which are significantly different from the described races that occur elsewhere in the world.

The major symptom of fusarium wilt of cotton in Australia is the extensive death of seedlings early in the season particularly if weather conditions are cool and wet. In the more susceptible cultivars all seedlings are killed and large bare areas develop in the field extending in the direction of furrow irrigation. Plants continue to wilt and die throughout the season. Cotton production has been abandoned in some fields as a result of Fusarium wilt. There are no nematodes associated with the disease.

A number of disease control strategies are being evaluated so that the impact of this disease on cotton production can be minimized.

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Discussion

Resistant Cultivars

Australian cotton breeding programs are having some success in their attempts to develop cultivars with better resistance than that which is currently available (Table 1). When environmental conditions favor the pathogen the more resistant commercial cultivars may suffer up to 80% seedling mortality compared to 100% seedling mortality in fully susceptible cultivars. Stronger resistance to the pathogen is being sought.

Summer Flooding

Three fields have been subjected to summer flooding for the control of Fusarium wilt of cotton. The disease was detected in three large patches in field “1" at “Tarrawatta” in December 1994 and the field was flooded for 60 days during the following summer. The field was planted to one of the “more resistant” cotton cultivars in 1996/97, 1997/98 and 1998/99. Fusarium wilt was not observed in either the 1996/97 or the 1998/99 seasons and only four isolated infected plants were found in the 1997/98 season.

Three large affected areas were detected in fields “5" and “6" at “Tarcoola North” in January 1998. These two fields were flooded during the 1998/99 summer and a “more resistant” cultivar planted in October 1999. No plants with symptoms of Fusarium wilt have been observed in these fields to date.

Summer flooding will not be an option for most cotton growers as it is reliant on the availability of water and the construction of suitable earthworks contain the water.

Managing Crop Residues

F. oxysporum f.sp. *vasinfectum* is able to survive as chlamydospores in association with crop residues. A large scale field experiment was established to determine if there was an advantage in retaining cotton crop residues on the soil surface for eight weeks prior to incorporation rather than incorporating them into the soil as soon as possible after harvest and slashing. Crop residues retained on the soil surface were exposed to sunlight and repeated wetting and drying cycles. Cotton was planted across the trial area in the following season and seedling mortality was assessed in the two treatments (Table 2). Fusarium wilt seedling mortality was reduced by 31% when infested cotton crop residues were retained on the surface for eight weeks prior to incorporation.

Crop Rotation

The most common rotation used in Australian cotton production systems is a winter cereal planted soon after the cotton harvest followed by a summer-winter fallow. According to Smith and Snyder, (1975) *F. oxysporum* f.sp. *vasinfectum* is able to survive and sometimes increase on residues of some cereal crops. A large scale field experiment was established to investigate the effect of a wheat fallow, barley fallow or long bare fallow crop rotation on the incidence of Fusarium wilt in a subsequent cotton crop. The rotations were established in May 1998 and managed according to commercial practice in plots 8 meters wide and 75 meters long. Cotton was planted across the trial area in October 1999 and seedling mortality was assessed six weeks later (Table 3). The incidence of seedling mortality resulting from Fusarium wilt was significantly lower following a long bare fallow than after either of the cereal fallow rotations.

Systemic Induced Resistance (SIR)

Plants have natural defense systems that may be activated to provide a broad spectrum increased resistance to pathogens. Colson et al., (1997) showed that chemically induced SIR could provide significant control of both foliar and vascular wilt pathogens of cotton. Benzothiadiazole (BTH) is a chemical activator of SIR which has been developed by Novartis (Gorlach et al., 1996).

It was suggested that the pre-soaking of seed in 25ppm BTH for 5 hours could provide induced resistance to cotton pathogens during the seedling stage of growth (A. H. Mondal *pers. comm*.). A small plot field experiment with 12 replicates and 24 seeds per plot was established to determine if manipulation of the natural plant resistance mechanisms could provide significant control of Fusarium wilt of cotton. The pre-soaking treatment with BTH significantly increased the survival of seedlings (Table 4).

Farm Hygiene

Inoculum of *F. oxysporum* f.sp. *vasinfectum* can survive and be dispersed in soil and crop residues. Soil was collected from the mudguards of 16 vehicles parked at the Australian Cotton Research Institute while the owners attended a meeting of farmers. Three of the 16 vehicles were found to be carrying *Thielaviopsis basicola*, 12 of the 16 vehicles were carrying *Verticillium dahliae* and *Fusarium* spp. were detected in samples from 15 of the 16 vehicles.

Considerable effort has been devoted to promoting the importance of cleaning machinery and vehicles before moving them between farms or production areas, particularly if Fusarium wilt is known to be present. An effective detergent/degreaser/disinfectant has been identified and is recommended for decontaminating vehicles and machinery.

Other Strategies

Several other control strategies are being developed and/or investigated. These include solarization for the treatment of small infected areas when the disease is first detected in an area or on a farm, fertilizer treatments, time of planting and biofumigation using either Brassica crops or hairy vetch green manure crops. Dr J. K. Kochman and Dr Natalie Moore of the Queensland Department of Primary Industries are also investigating a range of disease control strategies including an evaluation of seed treatments. Dr Subbu Putcha of NSW Agriculture has developed some promising bioocontrol treatments that have reached the stage of large scale field evaluation.

Summary

No single control measure will provide a satisfactory solution to the problem of Fusarium wilt of cotton in Australia. An integrated control strategy using a range of approaches must be developed to minimize the impact of this disease on Australian cotton production.

Acknowledgment

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References

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Table 1. Seedling mortality (%) at eight weeks after planting as a symptom of cultivar resistance or susceptibility to the Fusarium wilt pathogen*.

Culivar / reaction	Seedling mortality(%)
Fully susceptible	83.8%
"Resistant" commercial	55.9%
Experimental 1A	43.7%

* from J. K. Kochman.

Table 2. Fusarium wilt of cotton seedling mortality at six weeks after planting where infested crop residues were either retained on the soil surface for 8 weeks prior to incorporation or incorporated as soon as possible after harvest. (P=0.2)

Treatment	Dead seedlings/100m
Residues incorporated immediately	633.8
Residues retained on soil surface for 8 weeks	435.9

Table 3. Fusarium wilt of cotton seedling mortality at six weeks after planting following three different winter crop rotations. (P=0.01)

Crop rotation	Seedling mortality (%)
Long bare fallow	29.9 a
Wheat fallow	42.4 b
Barley fallow	41.6 b

Table 4. The effect of pre-soaking seed with 25ppm BTH (an activator of systemic induced resistance) on the incidence of Fusarium wilt of cotton at six weeks after planting. (P=0.2)

Treatment	Seedling survival (%)
Untreated control	21.7 a
Presoaked in water	19.2 a
Presoaked in BTH	37.9 b