VERTICILLIUM WILT

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Introduction

Verticillium wilt of cotton is caused by a fungus (*Verticillium dahliae*) that infects the host plant via the roots and colonises the vascular system. Symptoms therefore include a brown discoloration of the vascular tissue within the stem, branches and petioles and a yellowing and death of leaf tissue especially between the veins. The pathogen survives the intercrop period in association with infected crop debris or susceptible weed hosts. Verticillium wilt is favoured by cool soil conditions and symptoms are therefore most obvious in late spring and autumn. Yields may be reduced by up to 25% in seasons when environmental conditions favour the disease.

Results of Annual Disease Surveys

The distribution and incidence of verticillium wilt in commercial cotton crops growing in NSW cotton growing areas has been assessed during disease surveys in March of each year since 1985. The results *(see Figures 1, 2 and 3)* reflect the effects of seasonal weather conditions and indicate that the disease is present in a significant proportion of the fields inspected in all areas. Verticillium wilt is most prevalent in crops in the Namoi valley where it is now present in over 90% of crops and where the mean incidence for the last three seasons has been over 25%. It has been suggested that the use of susceptible cultivars, the increased adoption of reduced tillage practices and favourable weather conditions have all contributed to the increased incidence of the disease that has been observed in recent seasons.

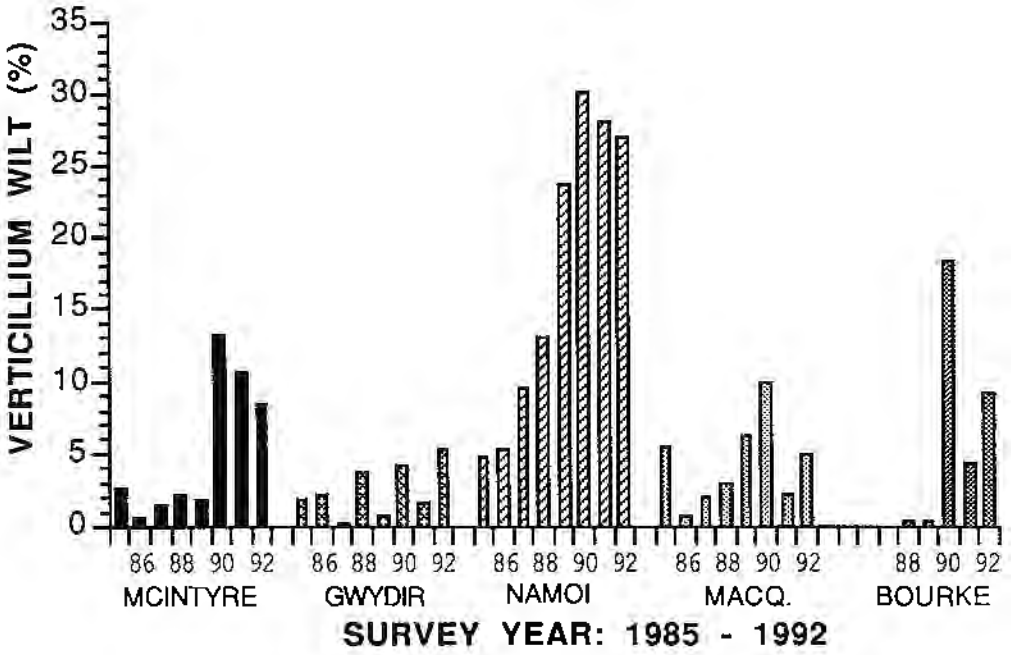

Figure 1. The mean incidence (%) of verticillium wilt in commercial cotton crops in the major production areas of New South Wales as determined during disease surveys in March of each season.

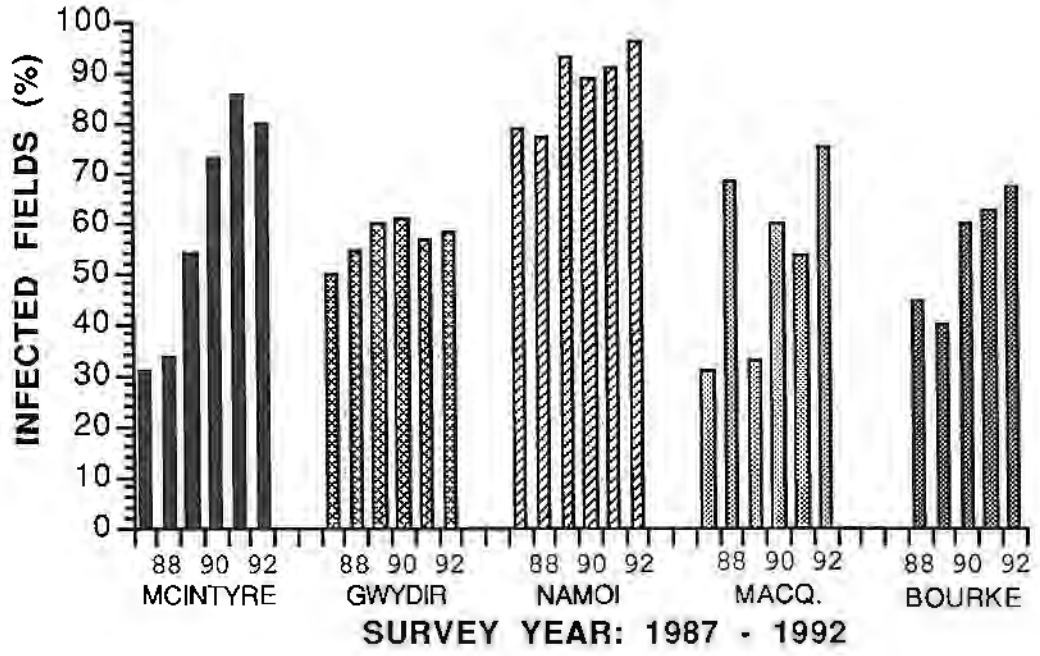

Figure 2. The percentage of fields inspected where Verticillium wilt was found to be present - in the major production areas of New South Wales as determined during disease surveys in March of each season.

The increasing incidence of verticillium wilt in individual fields that have been surveyed on several occasions during the last six seasons is of particular concern (See Figure 3). These results demonstrate the capacity of the disease to increase from season to season in different areas under different farming practices.

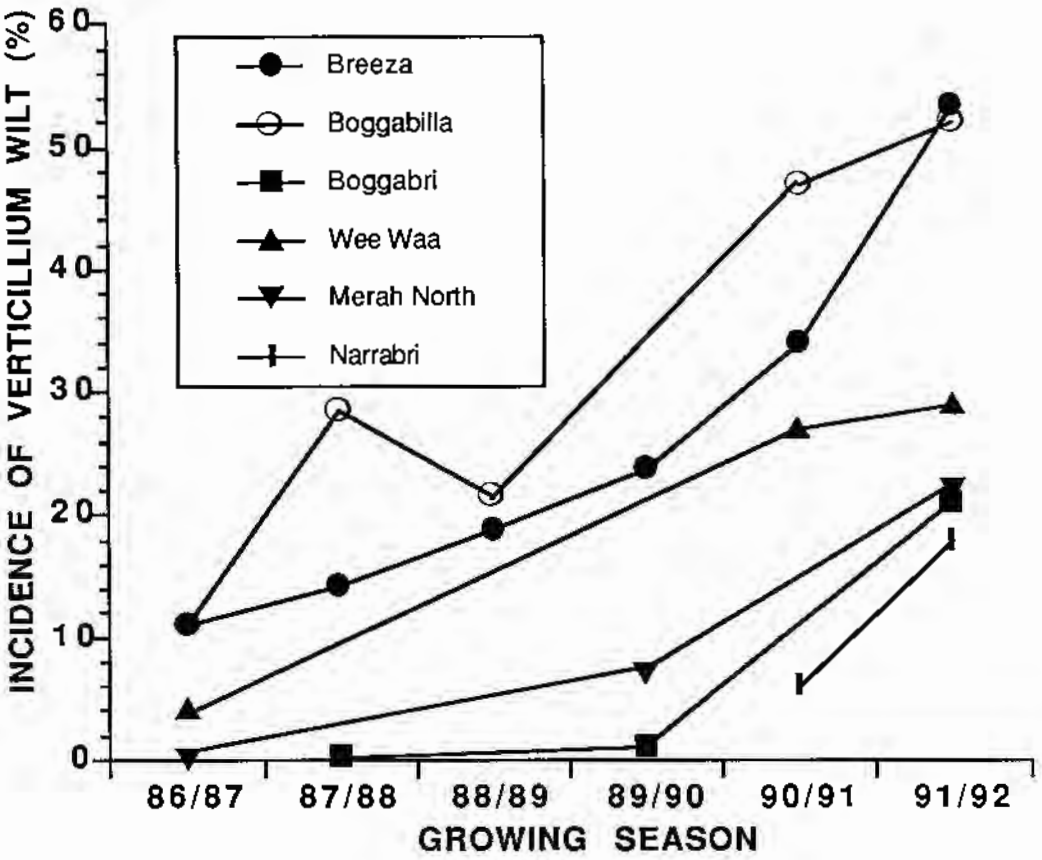

Figure 3. The increasing incidence of Verticillium wilt in selected commercial cotton fields as determined during disease surveys in March of each season.

Control by Cultural Methods

The use of various cultural practices for the control of verticillium wilt of cotton has been discussed previously. Crop rotation, the elimination or incorporation of crop residues, effective weed control, a good even plant stand, avoiding excessive use of nitrogen and water and managing the crop for earliness are all important if the disease is present. These methods will not eliminate the pathogen from the field but can be effective in either reducing the rate of build-up of the pathogen within a field or reducing the impact of the disease when it is present.

Control by Biological Methods

Resistant Cultivars

Perhaps the most significant development in the control of verticillium wilt of cotton in Australia has been the release of cultivars with improved resistance to the pathogen. Sicala V1 has been shown (Table 1) to be significantly more resistant to the disease than all other commercial cultivars currently available. The mechanism of this resistance is not presently understood and it is not known if the type of resistance present in Sicala V1 is the same as that which is widely utilised in Californian cultivars with resistance to verticillium wilt.

Table 1. The results of eight field trials over three seasons comparing the relative resistance/susceptibility of current commercial cultivars to verticillium wilt of cotton.

Cultivar	89/90 Myall Vale	89/90 Auscott N'bri	89/90 CSD N'bri	90/91 CSD Dalby	90/91 CSD N'bri	91/92 CSD N'bri	91/92 CSD Merah	91/92 Auscott N'bri	Mean
Sicala V1	28.2	-	35.3	19.5	41.4	13.9	48.3	41.8	32.6
CS-189	-	64.0	44.8	48.0	72.8	19.5	87.7	54.0	55.8
DPL 90	46.6	68.6	44.3	57.7	73.4	24.4	89.1	56.6	57.6
Sicala 33	57.3	72.4	63.2	48.0	84.8	16.3	86.3	71.0	62.4
Siokra 1-4	58.5	85.5	61.3	68.9	85.0	22.3	95.7	72.9	68.8
LSD	11.5	7.0	8.8	12.1	8.0	6.1	9.4	8.2	

Use of Antagonists and/or Hyperparasites

Verticillium wilt of egg plant has been successfully controlled in the Eastern USA using a fungus (*Talaromyces*) which is established on the surface of the roots of the egg plant host. This fungus produces an enzyme which converts glucose into peroxide which is toxic to the pathogen - thereby protecting the host from infection.

Financial support from the Cotton Research and Development Corporation has enabled the establishment of a research programme at Narrabri to evaluate the potential use of fungi and bacteria as antagonists or parasites of the verticillium wilt

pathogen in cotton. Several antagonistic micro-organisms have already been isolated from the roots of healthy cotton plants growing in heavily infested fields and from infested crop debris from a previous season. These micro-organisms along with other potential biocontrol agents are being evaluated in relation to two possible application strategies :

(i) the application of the biocontrol agent to the crop residues after harvest so that it can attack the resting or survival stage of the pathogen during the intercrop period.

(ii) the application of the biocontrol agent on the seed at planting so that it can become established on the roots and protect the host plant from infection by the pathogen.

Potential for Genetic Engineering

There are various possibilities for improved control of verticillium wilt resulting from developments in the area of 'biotechnology' and genetic engineering. Staff of the CSIRO Division of Plant Industries in Canberra are developing research programmes in this area. Miss Fiona Murray, studying under a scholarship from Cotton Seed Distributors Ltd., has obtained the gene for glucose oxidase (which converts glucose into peroxide which inhibits the verticillium wilt pathogen) production and is investigating the use of this gene by either inserting it into the host plant or by inserting it into a fungus or bacterium which could then be applied at planting and used as a biocontrol agent.

Other research programmes at CSIRO Canberra are evaluating the possibility of manipulating the natural plant defense mechanisms and identifying 'gene specific promoters' which will localise the production of anti-pathogen substances in specific parts of the plant. This planned work will initially use other host plant systems and will only be extended to cotton if successful.

Variation in the Pathogen

At the 1992 Beltwide conferences Al Bell (USDA, College Station, Texas) reported extensive studies comparing isolates of *Verticillium dahliae* from several crops and from 16 different countries. These isolates were classified into distinct groups on the basis of vegetative compatibility. Group 1 isolates are the most virulent isolates that occur on cotton and include the severe, defoliating strains that appear to have originated in south and south-west USA. In recent years these isolates have appeared in several other countries. Group 2 isolates are the next most virulent and occur on cotton in most other countries. Group 4 isolates are the least virulent and only occur on cotton in Australia despite occurring on sunflower and hops in north America and other parts of the world.

A co-operative study involving NSW Agriculture at Narrabri and Dr John Brown and an Honours student at the University of New England investigated the possibility of pathogenic variation among 34 isolates of *Verticillium dahliae* collected from Australian cotton growing areas. No significant differences were found between isolates when colony morphology and growth characteristics and virulence to cotton were compared. Dr. Bruce Lyon (Sydney University) has obtained a selection of these isolates and plans to use more sophisticated molecular techniques to detect variation between Australian isolates of the pathogen if present.

QUARANTINE IS IMPORTANT !!

It is of great importance that the severe defoliating group 1 strains of the verticillium wilt pathogen are not accidentally introduced into Australia. There are many other diseases that are present in overseas cotton growing areas which are not present in Australia. Those who travel to these areas should ensure that their shoes etc are thoroughly cleaned before returning to Australia. Imported second-hand machinery should be thoroughly cleaned before removal from its country of origin. Full compliance with Quarantine regulations is essential.

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