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THE IMPACT OF DISEASE INCIDENCE AND SEVERITY ON THE YIELD OF COTTON IN AUSTRALIA

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Abstract

Since 1983 annual surveys have monitored disease incidence and severity in commercial cotton crops in the major production areas of New South Wales (NSW), Australia. Significant epidemics of bacterial blight and Verticillium wilt have occurred during this period. Major epidemics of black root rot and Fusarium wilt are now developing. The relationship between average annual lint yields and disease incidence or severity is investigated at the state, regional and local level. Seasonal weather conditions (droughts, floods, wet harvests, cool springs, etc) appear to have had a greater impact than disease on average lint yields.

Introduction

Average cotton yields in the USA have shown some decline in recent seasons and this has prompted a review of the possible factors contributing to the observed 'yield stagnation'. Various possible explanations have been advanced including weather conditions, disease or pest pressure, variety performance and variety selection, etc.

In Australia cotton is produced mostly under irrigation, in inland river valleys, on heavy, cracking clay soils of high fertility (Constable, 1992). There has been a national average yield increase of over 23kg lint per hectare per year over the last 30 years and Constable (2000) suggested that the factors that have contributed to this increasing yield include: varietal improvement; improved soil-nutrition-irrigation management; improved insect control; and improved disease management.

The results of annual disease surveys were compared to average lint yields to determine if there was any apparent relationship between the occurrence of disease epidemics and average lint yields in Australia. This comparison and possible interaction was investigated at the state (NSW), regional (Namoi valley) and local level (Farm A). 'Farm A' is situated in the higher rainfall portion of the Namoi valley near Narrabri.

Annual Disease Surveys

Since 1983 annual disease surveys have been completed in November and March of each season (Allen, 1992). Between 80 and 100 commercial cotton crops have been inspected in each survey with 20 to 25 fields in each of the four major production regions in NSW. Two to five fields are checked on each of several farms that are distributed throughout each production region. The field history, ground preparation, variety, planting date, plant stand and the amount of cotton crop residues from the previous seasons, as well as disease incidence and severity, are recorded for each field and entered into a database.

The Bacterial Blight Epidemic

Bacterial blight, caused by *Xanthomonas campestris* pv. *malvacearum* (Smith) Dye, was common and widespread during the mid 1980's (Figure 1) when all available commercial varieties were susceptible to the disease. In March 1985, the mean incidence of bacterial blight on bolls was nearly 25% for both NSW and the Namoi valley of NSW but over 40% for the crops surveyed on 'Farm A' in the Namoi valley. Up to 60% of bolls were affected in some fields. The average lint yield for 'Farm A' was 0.89 bales/hectare lower than that for NSW during the 1984/85, 1985/86 and 1986/87 seasons.

The development of a seed scheme to minimize the level of seed infestation by the blight pathogen in susceptible varieties and the release of blight resistant varieties resulted in a rapid decline in the importance of the disease. All Australian bred cotton varieties are now resistant to bacterial blight and the disease is only considered a threat to 'Pima' cotton which is very susceptible.

The Verticillium Wilt Epidemic

Verticillium wilt, caused by *Verticillium dahliae* Kleb., increased in importance in Australia during the late 1980's (Figure 2). This increase coincided with the adoption of permanent bed or reduced tillage systems that retained more crop residues

from season to season and also with the widespread use of susceptible varieties. Australian strains of the pathogen were described as 'mild, non defoliating SS-4 ' strains by Schnathorst and Evans (1971).

Verticillium wilt is favored by cool conditions and was therefore more common in the central and southern production regions of NSW. The disease usually becomes most apparent late in the season as weather conditions cool and when the impact on yield is not as significant. However, yield reductions of up to 20% have been observed when cooler and/or wet conditions occur in mid to late summer. In March, 1990, the mean incidence of Verticillium wilt was approximately 16% for NSW compared to 30% for the Namoi valley and nearly 60% for those crops inspected on Farm A. The average lint yield for 'Farm A' was 0.64 bales/hectare lower than that for NSW during the 1988/89, 1989/90, 1990/91 and 1991/92 seasons.

Varieties with significant resistance to Verticillium wilt were released in 1990 and in recent years over 85% of the area sown to cotton has used these more resistant varieties. Consequently the incidence of this disease has declined considerably (Figure 2).

Black Root Rot and Fusarium Wilt

Black root rot of cotton, caused by *Thielaviopsis basicola* (Berk. & Br.) Ferraris, was first reported in Australia in 1990 (Allen, 1990). The disease has become widespread and in the 2000/01 season it was found on over 60% of the farms that were visited during the disease surveys (Figure 3). Generally the incidence is low but black root rot is rapidly increasing in importance.

Fusarium wilt of cotton, caused by *Fusarium oxysporum* Schlecht. f.sp. *vasinfectum* (atk.) Snyd. & Hans., was first reported in Australia in 1995 (Kochman, 1995) from plants collected in Queensland in the 1992/93 season. The disease was first observed in NSW in the 1994/95 season and has now been confirmed on 43 farms (Figure 3). In most cases the disease is present in small patches in only one or two fields on the farm.

Relationship Between Disease Incidence and Lint Yield

The average lint yields for each season are plotted against disease incidence at the state (Figure 4 - NSW), regional (Figure 5 – Namoi valley) and local level (Figure 6 – Farm A). There is no apparent relationship between disease and yield at the state and regional level. The lower average lint yields that are obvious in Figures 4, 5 and 6 can generally be explained by seasonal conditions as follows:

1983/84 - Severe floods.
1987/88 - Hail and storms, wet finish to the season with some flooding.
1989/90 - Very cool early in season, wet February in some areas, wet finish to the season.
1992/93 to 1994/95 – Severe drought with restricted irrigation water supply.
1995/96 – Wet both early and late in the season, cool mid-season.
1998/99 – Wet during ground preparation, wet finish to the season, heavy pest pressure.

There are some possible impacts of disease on yield in the data for 'Farm A' (Figure 6). The average lint yield for the last eight years of the study period on 'farm A' was 7.08 bales/hectare compared to only 5.52 bales/hectare for the first eight years when the bacterial blight and Verticillium wilt epidemics were occurring. This represents a 28% increase in lint yield in the absence of disease although other factors such as varietal improvement could have contributed to this increase. In the 1989/90 season the Verticillium wilt epidemic peaked and average lint yield on 'Farm A' was reduced. It is interesting to note that this area received three times the normal February rainfall during this season.

Conclusions

The data presented here demonstrate that, under Australian conditions, environmental factors have had a greater effect on average lint yields than the impact of bacterial blight and Verticillium wilt epidemics, when considered at the state or regional level. However, at the local level on 'Farm A', where disease incidence was particularly high, there does appear to be a relationship between yield and disease that can be observed in long term yield trends. A further consideration could be whether or not the seasonal conditions that favor higher crop yield potential are also the seasonal conditions that favor higher disease incidence?

References

Allen, S.J. 1990. *Thielaviopsis basicola*, a new record on cotton in Australia. Australasian Plant Pathology 19(1): 24-25.

Allen, S.J. 1992. The distribution, importance and control of diseases of cotton in Australia. Proceedings of the Beltwide Cotton Conference Volume 1:174-176 (1992). 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.

Constable, G.A. 1992. What's new in Australian cotton production and research. Proceedings of the Beltwide Cotton Conference Volume 1:143-145 (1992). National Cotton Council, Memphis, TN.

Constable, G.A. 2000. The components of high yields in Australia. ICAC Recorder. 18(3): 3-8.

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

Schnathorst, W.C. and G. Evans. 1971. Comparative virulence of American and Australian isolates of *Verticillium albo-atrum* in *Gossypium hirsutum*. Plant Dis. Reptr. 55: 977-980.

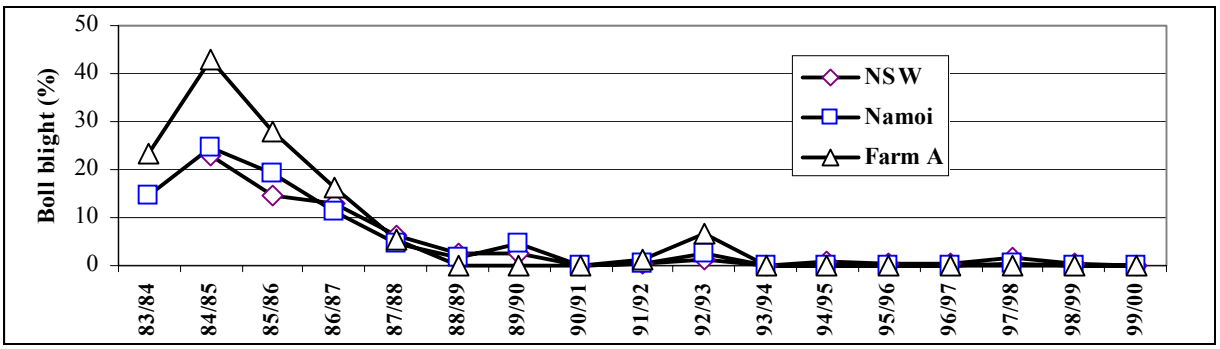

Figure 1. The incidence of bacterial blight on bolls at the State, regional or local level.

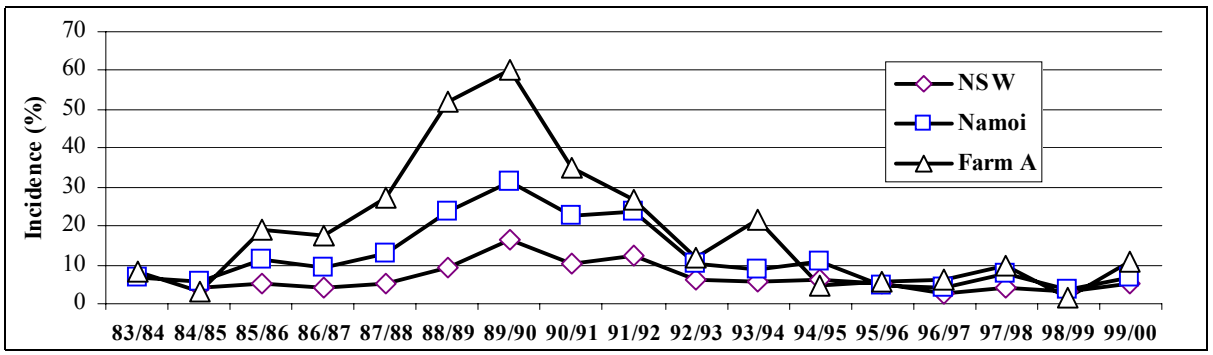

Figure 2. The incidence of Verticillium wilt of cotton at the State, regional and local level.

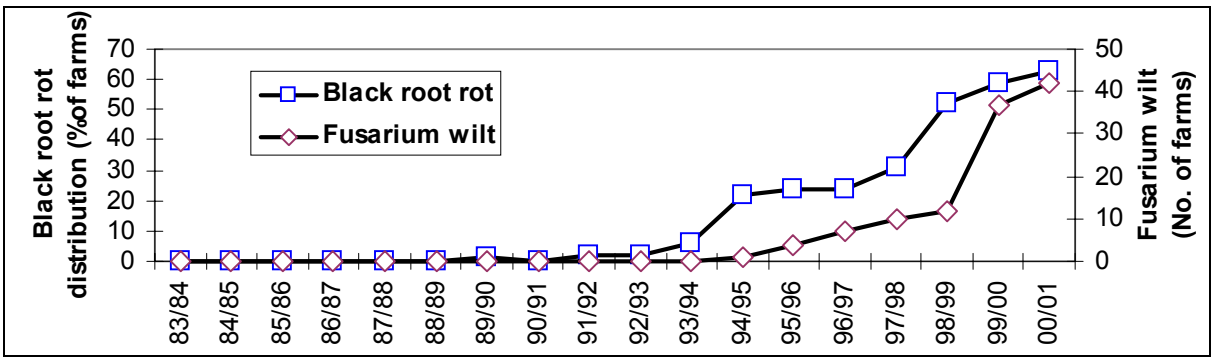

Figure 3. The incidence of black root rot and Fusarium wilt in NSW.

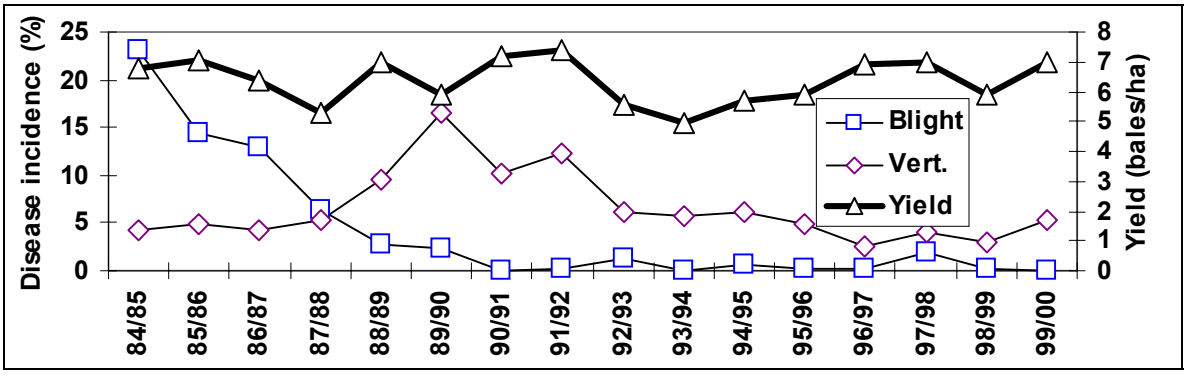

Figure 4. Average lint yields and disease incidence for all crops surveyed in NSW.

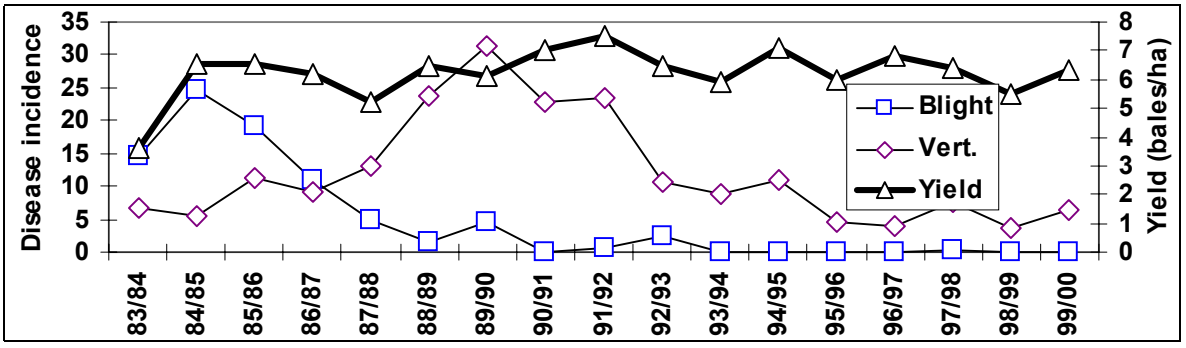

Figure 5. Average lint yields and disease incidence for crops surveyed in the Namoi valley of NSW.

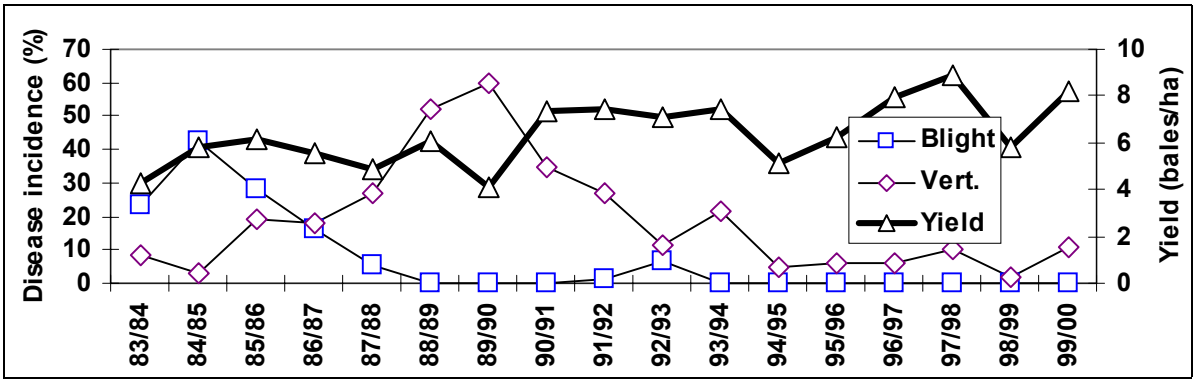

Figure 6. Average lint yields and disease incidence of crops surveyed on 'Farm A' in the Namoi valley in NSW.