

# COTTON DISEASES: THREATS AND EMERGING THREATS

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## Summary

Plant diseases are currently threatening the productivity and sustainability of the cotton industry. Regular disease surveys in NSW have enabled accurate observation of the changing distribution and severity of diseases over time. The relative risks are low for boll rots, *Alternaria* leaf spot and bacterial blight, medium for seedling disease and *Verticillium* wilt, and high for black root rot and *Fusarium* wilt. Issues that need to be addressed include regional differences, potential new threats, and the complexity of pathosystems (pathogens × hosts × fields × regions). Research should include (i) continued investigation of factors contributing to the spread and severity of diseases and (ii) further development and evaluation of tools for integrated disease management.

## Low-level threats

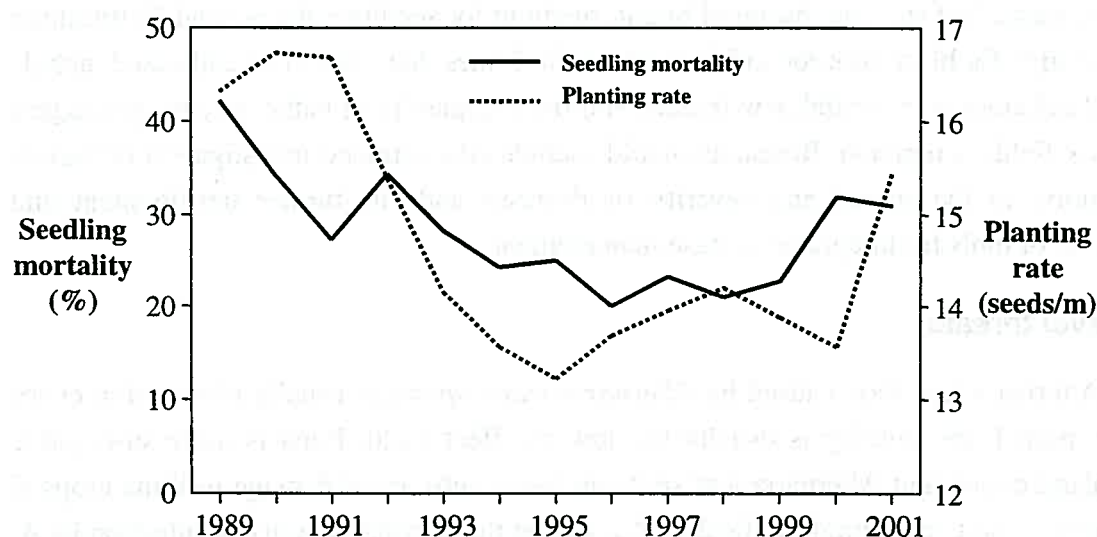
While *Alternaria* leaf spot, caused by *Alternaria macrospora*, is usually observed in every crop examined, the severity is usually too low to affect yield. Pima is more susceptible than upland cotton and *Alternaria* leaf spot can cause substantial damage to Pima crops if conditions are wet and humid. In the 2001/02 season the average severity of infection by *A. macrospora* across all of NSW was 0.16% of leaf area.

Nowadays, bacterial blight is rarely observed in upland cotton, even in those varieties that are susceptible. Bacterial blight can damage Pima crops but has been minimised in recent years by the selection of clean seed for planting and by rotating fields with upland cotton or other crops.

*Phytophthora* boll rot develops when low bolls are inundated with flood or irrigation water or when soil is splashed up onto low bolls as they approach maturity. The incidence of *Phytophthora* boll rot is generally low, averaging 1.9 % of bolls across NSW in the last nine seasons. Boll rots caused by other fungi are most common in tall rank crops with dense canopies, particularly when combined with extended periods of wet and overcast weather late in the season. The incidence of 'other' boll rots was 1.7% over the last nine seasons. Localised heavy rainfall has caused significant losses to boll rots in a few crops in recent years. Since boll rots are related to seasonal conditions and severe losses are not recurrent, these pathogens do not present a major threat to cotton at this point in time.

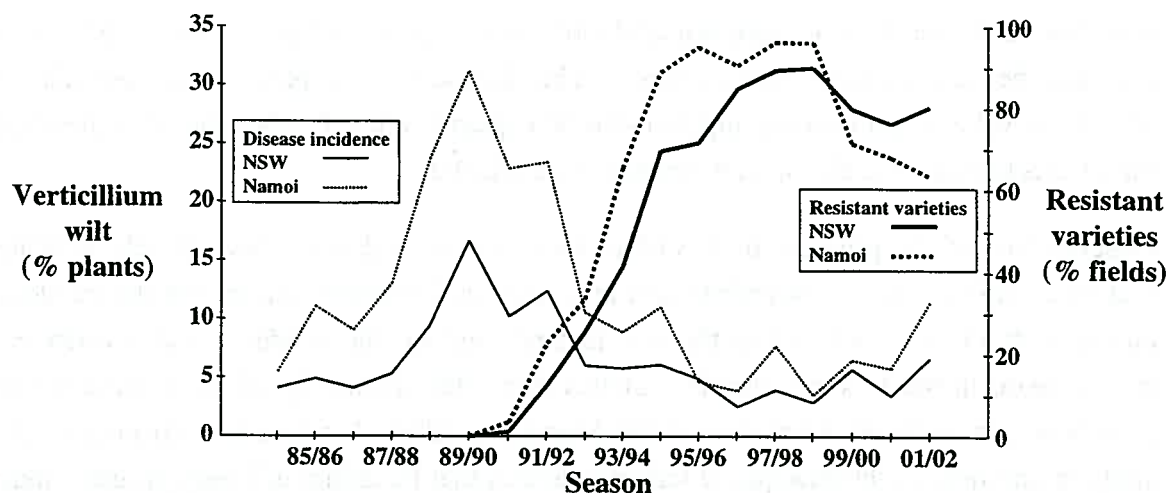
## Medium-level threats

Seedling disease caused by *Rhizoctonia* and *Pythium*, is a major factor in seedling mortality, which was unusually severe in the 2000-01 and 2001-02 seasons. (Figure 1). In contrast to the 2000 sowing, there were fewer reports of replanting in 2001. This probably reflects the fact that growers planted an extra 1.9 seeds per m on average in the 2001-02 season (Figure 1). These recent increases in seedling mortality were primarily related to prolonged cool wet conditions early in the season, although black root rot may also contribute to the severity of seedling disease. The new areas of cotton in southern NSW face a greater risk from seedling disease due to cooler conditions. Disease control strategies need to be tailored to meet the needs of these developing areas.



**Figure 1.** Changes in sowing rate in relation to seedling mortality of cotton in NSW.

Overall, the 2001/2002 season was very favourable to the *Verticillium* wilt pathogen and the mean incidence of the disease in commercial crops in NSW was 6.7% of plants, compared to an average of 3.7% over the previous five seasons. A concern is the average in the Namoi valley of 11.4% of plants, compared to 5.5% over the previous five seasons (Figure 2). This greater level of *Verticillium* wilt in the Namoi valley probably reflects the declining use of resistant varieties. Four and five years ago 96% of the Namoi valley was sown to resistant varieties, yet only 63% of the crop was resistant varieties in 2001-02 (Figure 2).



**Figure 2.** Relationship between the incidence of Verticillium wilt of cotton and the use of Verticillium-resistant varieties in NSW and the Namoi valley.

In the 2001-02 season, susceptible varieties had very little Verticillium wilt in some fields, while in other fields the disease was rampant in the same variety, reflecting the presence of the pathogen due to prior cropping history (Table 1). If the trend for declining use of resistant varieties continues, then the severity of Verticillium wilt will increase accordingly and yield losses will occur.

**Table 1.** Variation in the level of Verticillium wilt in a Verticillium-susceptible cotton variety in the 2001-02 season (six of the previous nine cotton crops in the Baan Baa field were susceptible varieties).

Location	Verticillium wilt incidence (% plants)
Baan Baa	46
Collarenabri	0
Merah North	0
Wee Waa	24.5

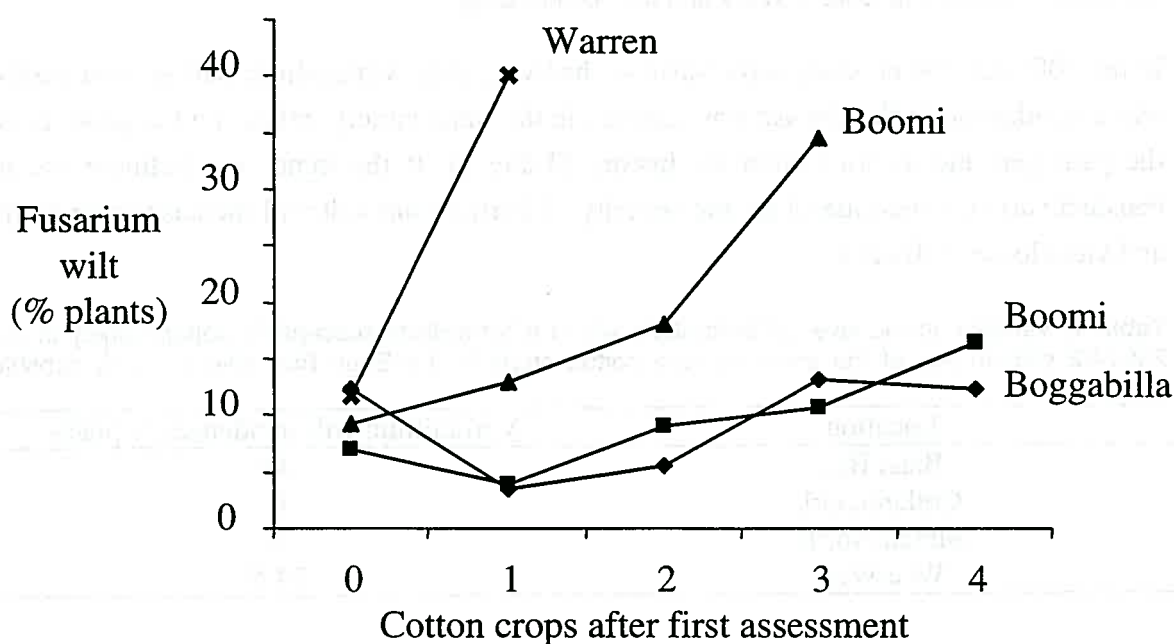
### High-level threats

Black root rot now occurs in 98% of farms that are regularly inspected in the disease surveys by NSW Agriculture in the Macintyre, Gwydir, Namoi and Macquarie valleys. More than 65% of the fields inspected in these areas in the 2001-2002 season had the disease, averaging 28% of plants. Across the whole of NSW (including regions where the disease has not yet been observed) an average of 21% of plants were infected by the black root rot fungus. The severity of black root rot increases with successive cotton crops and there are currently no adequate control measures. NSW is currently experiencing a widespread epidemic of black root rot.

Fusarium wilt is not as widespread as other diseases but its distribution is increasing at an exponential rate. NSW is currently at the onset of an epidemic of Fusarium wilt. Fusarium

wilt has been reported on approximately 60 farms but the exact figure is difficult to ascertain because of anonymous samples. The disease is widespread in the Gwydir and Macintyre valleys and is becoming so in the Macquarie valley. Further spread is inevitable but efforts to minimise this spread should not be relaxed.

Observations of the progress of Fusarium wilt over several years have clearly indicated that (i) changing from a susceptible to a less susceptible variety will reduce the incidence and severity of Fusarium wilt in the first instance and (ii) the incidence and severity will still increase in the less susceptible varieties thereafter (Figure 3). Most of these studies have been conducted in warm areas in the Macintyre valley. The first result from a parallel study in one field in the Macquarie valley indicates that Fusarium wilt *may* progress much faster in cooler areas (Figure 3).



**Figure 3.** Changing incidence of Fusarium wilt across transects of four different cotton fields in NSW (in all cases the fields were sown with less-susceptible cotton varieties after the initial year when disease incidence was recorded).

### Conclusions

The potential for regional differences in the severity of diseases is very real, particularly for seedling disease and Fusarium wilt. These differences need to be accounted for in the development and deployment of control strategies.

The potential for new threats is ongoing. In particular, a number of cases of very severe Verticillium wilt have been reported in the last two seasons. It is possible that the continuous use of varieties with resistance against Verticillium wilt has selected for strains of the pathogen that are more virulent.

The pathosystem faced by cotton growers is complex and includes several pathogens, interacting with a range of hosts, in many fields, and across whole regions. The control measures for one disease may enhance another disease. For example, when used as 'biofumigation' crops, wooly pod vetch, mustard and canola can reduce the severity of black root rot but, in contrast, they increase the severity of Fusarium wilt (see Managing Disease with Rotations, this proceedings). A cautious and scientific approach is required in developing new control methods for diseases. Integrated disease management will be the best approach in the long-term.

### **Acknowledgements**

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The first part of the paper is devoted to the study of the asymptotic behavior of the solutions of the system (1) as  $t \rightarrow \infty$ . It is shown that the solutions of the system (1) tend to zero as  $t \rightarrow \infty$  if and only if the matrix  $A$  is stable. This result is proved by using the method of the variation of constants.

### References

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