

INTEGRATED DISEASE MANAGEMENT HOW ARE WE DOING?

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A plant disease is an interaction between a plant host, a pathogen and the environment. Most plants are immune or completely resistant to almost all plant pathogens. When a virulent pathogen is dispersed onto a susceptible host and the environmental conditions are suitable then a plant disease develops and symptoms become evident. Disease control strategies must therefore focus on the host, the pathogen and/or the environment. 'Integrated Disease Management' involves the selection and application of a harmonious range of control strategies that minimise losses and maximise returns.

The Host

A particular cultivar may be immune, resistant or susceptible. Plants of an immune cultivar are not infected by the pathogen while pathogen growth and multiplication is unrestricted in a susceptible cultivar. Resistance may appear as less spots or smaller spots on leaves or bolls, less plants affected, symptoms less severe, less spores produced, slower spread of the pathogen in the plant etc. etc. Plant breeders often use the word 'tolerance' to imply good performance (yield) despite the presence of disease.

Disease control strategies focussed on the host include:

- 1) *The use of resistant cultivars.* Australian bred cotton cultivars are completely resistant to the bacterial blight pathogen. Some cultivars have good resistance to Verticillium wilt and some cultivars have some resistance to Fusarium wilt.
- 2) *The application of systemic activators or biocontrol agents to 'turn on' the host plant's natural defence mechanisms.* Dr Emma Colson's work showed that the application of a systemic activator could induce stronger resistance resulting in reduced severity of Alternaria leaf spot and Verticillium wilt of cotton.
- 3) *Provision of balanced crop nutrition.* Eg. potassium deficiency results in increased susceptibility to Alternaria leaf spot.

The Pathogen

A pathogen must be present in the area, capable of surviving the inter-crop period and adapted for effective dispersal between host plants if a disease is to occur. Disease control strategies that focus on the pathogen therefore include:

- 1) *Exclusion of the pathogen from an area* ('Come clean' and quarantine). There are diseases of cotton that occur overseas that are not present in Australia. There are diseases of cotton that occur elsewhere in Australia that may not occur on your farm. There are diseases of cotton that may be present in some fields on your farm but not in others.
- 2) *Control of alternative weed hosts.* The pathogens that cause Verticillium wilt, Fusarium wilt, black root rot and Alternaria leaf spot can also infect common weeds found in cotton growing areas.
- 3) *Use of rotation crops that are not hosts.* Most legume crops are also hosts of the black root rot pathogen. The Verticillium wilt pathogen has a large host range.
- 4) *Crop residue management to reduce pathogen survival and eliminate sources of infection.* The pathogens that cause Verticillium wilt, Fusarium wilt, black root rot, bacterial blight, boll rots, seedling disease and Alternaria leaf spot can all survive in association with crop residues. The Fusarium wilt pathogen can also survive and multiply on the residues of non-host crops.
- 5) *Application of biocides* Eg. seed treatments for seedling disease control and foliar sprays for the control of Alternaria leaf spot on Pima cotton.

- 6) *Control of insect vectors.* Diseases caused by a virus or phytoplasma can often be controlled by controlling the vector that carries the pathogen.
- 7) Application of biocontrol agents that antagonise, inhibit or compete with the pathogen.

The Environment

Pathogens have optimum temperature, relative humidity, leaf wetness and/or soil moisture content requirements for infection to occur and for the disease to spread and multiply in the host plant. When environmental conditions are not optimal then the rate of disease development is reduced.

It may appear difficult to manipulate the environment but it can be achieved by altering row or plant spacing, irrigation method or frequency or by changing the sowing date. Possible disease control strategies that focus on the environment include:

- 1) *Good bed preparation.* Well prepared, firm, high beds are more conducive to good seedling emergence than low, loose beds.
- 2) *Timing and frequency of irrigation.* Applying water prior to planting provides better conditions for seedling emergence than watering after planting. Irrigations late in the season can result in a higher incidence of Verticillium wilt.
- 3) Crop management to avoid rank growth and a dense canopy. The high relative humidity associated with rank growth and a dense canopy favours development of bacterial blight, Alternaria leaf spot and boll rots.
- 4) *Choosing a sowing date that provides optimum conditions for germination.*
- 5) *Crop management for early harvest.* Verticillium wilt is favoured by the cool conditions at the end of the season.

Integrated Disease Management

As indicated earlier 'Integrated Disease Management' involves the selection and application of a harmonious range of disease control strategies that minimise losses and maximise returns. It can be considered at two levels.

Integrated Disease Management for Specific Diseases

In subsequent papers Dr Joe Kochman will discuss management strategies for Fusarium wilt of cotton and Dr David Nehl will discuss control strategies for black root rot. These strategies are applicable for a specific disease problem.

An Integrated Disease Management strategy for seedling diseases of cotton would include:

- i) Use of a cultivar with good seedling vigour
- ii) Planting into well prepared, high, firm beds
- iii) Careful positioning of fertiliser in the bed
- iv) Early incorporation of residues of the previous crop
- v) Delayed planting until temperature and moisture conditions are optimum
- vi) Planting into moisture rather than watering-up
- vii) Use of effective seed treatment fungicides
- viii) Careful use of herbicides at planting

Integrated Disease Management for Verticillium wilt of cotton:

- i) Use of a resistant cultivar
- ii) Control alternative weed hosts
- iii) Rotation with non-host crops
- iv) Provide balanced crop nutrition (especially nitrogen and potassium)
- v) Manage for earliness
- vi) Avoid late irrigations and long periods of waterlogging
- vii) Incorporate crop residues as soon as possible after harvest
- viii) Minimise the movement of crop residues in tailwater recirculation systems

Integrated Disease Management for Alternaria leaf spot of cotton:

- i) Avoid susceptible cultivars
- ii) Control alternative weed hosts
- iii) Incorporate crop residues as soon as possible after harvest
- iv) Provide balanced crop nutrition (especially potassium)
- v) Use foliar fungicide applications for Pima cultivars

Integrated Disease Management for bacterial blight in susceptible cultivars:

- i) Seed companies should ensure minimal carryover of the pathogen in planting seed
- ii) Do not plant susceptible cultivars in or near fields that contain residues of susceptible cultivars grown in the previous season
- iii) Avoid rank growth and a dense crop canopy if possible
- iv) Thoroughly incorporate crop residues as soon as possible after harvest

Integrated Disease Management for boll rots:

- i) Avoid rank growth and a dense crop canopy if possible
- ii) Thoroughly incorporate crop residues as soon as possible after harvest
- iii) Field drainage should not allow water to back-up into the field and inundate low bolls on plants near the tail drain
- iv) Avoid very low plant populations which result in exposed soil that can be splashed up onto low bolls at the end of the season

Integrated Disease Management at the Farm Level

Effective disease management must be integrated with management of the whole farm. Basic strategies should be implemented regardless of whether or not a significant disease problem exists. These basic strategies include the following:

1. *Do your own disease survey every year.* Be aware of what diseases are present and where they are present and whether or not they are increasing.
2. *Practice farm hygiene principles.* Minimise the movement of pathogens either onto or off your farm or from one field to another on your farm
3. *Use resistant cultivars where available.*
4. *Provide a balanced crop nutrition.* A healthy crop is more able to express its natural resistance to disease.
5. *Manage crop residues to minimise carryover of pathogens into subsequent crops.*
6. *Develop a sound crop rotation strategy.* Repeated cultivation of cotton can contribute to a rapid increase in disease incidence - especially if susceptible cultivars are used.

How are we doing?

Commercial cotton crops throughout NSW production areas have been inspected twice each season for the last 17 years and disease incidence and severity have been recorded. These disease survey results indicate how we are doing with regards to disease management.

Bacterial blight has almost disappeared and is only ever seen in the older US cultivars and in Pima cotton. The mean incidence of Verticillium wilt has declined considerably since peaking in 1989/90. The introduction and widespread use of resistant cultivars have contributed significantly to these results. There has been a steady decline in mean seedling mortality over the last 15 years. For these three diseases we have made excellent progress. However, there is still room for improvement.

The occurrence of Alternaria leaf spot and boll rots is closely associated with weather conditions. The impact of these diseases will vary according to seasonal conditions. Sources of pathogen inoculum are common and widespread. Boll rots are unavoidable and potentially devastating when extended periods of wet, overcast weather occur late in the season. Alternaria leaf spot can defoliate crops prematurely under similar conditions. There is much room for improvement.

The increasing distribution and incidence of Fusarium wilt and black root rot is alarming. These two diseases were not observed in Australia until late in the 1980's and the first reports of their presence did not appear until early in the 1990's. They have quickly become of major significance to the Australian cotton industry. Pathologists were advocating more common availability and use of wash-down facilities several years ago. However, it is only in the last year that the advice has been taken more seriously. These two diseases are the subject of subsequent papers in these proceedings. For Fusarium wilt and black root rot we are not doing very well!

Conclusions

It is relatively easy for cotton pathologists to develop and recommend an Integrated Disease Management strategy. The real challenge is for growers and consultants to integrate these recommendations with the recommendations in ENTOPak, SOILpak, NUTRIpak, MACHINE-pak and possibly a future WEEDpak. All of this information then has to be further integrated with current weather and weather forecasts, market forecasts and economic forecasts from the bank manager or shareholders! Growers and consultants are the real integrators! I wish them well!!