3.5 Irrigation and cotton disease interactions

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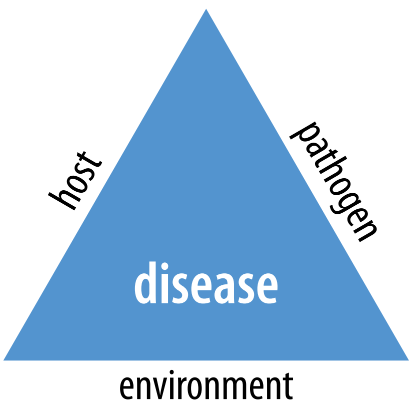
Key points

- Irrigation followed by rainfall and cool weather conditions have contributed to the incidence of Fusarium wilt, black root rot and Verticillium wilt in the Australian cotton industry.
- Irrigation practices can be modified to reduce the incidence of plant disease and their spread within the field and farm.

Plant diseases occur when a virulent pathogen interacts with a susceptible plant host under favourable environmental conditions. These three factors constitute the three sides of the 'disease triangle' and all three must be present for a disease to develop (see Integrated Disease Management Guidelines).

Plant diseases are usually a man-made problem. Irrigated cotton farming systems generally favour the survival and dispersal of the pathogens that cause diseases of cotton and often provide environments conducive to infection. Irrigation practices have contributed significantly to the development of the Fusarium wilt, black root rot and Verticillium wilt problems that are a concern to Australian cotton growers.

The disease triangle



The objective of this chapter is to discuss the positive and negative impacts of irrigation practices on the three components of the 'disease triangle' and to propose possible strategies to minimise the negative impacts on the sustainability and profitability of cotton farming.

The impact of irrigation practices on the pathogen

Dispersal of the pathogen within the field

Dispersal from field to field, that is, introducing the pathogen to new fields

Water moving down a furrow and into and along a tail drain carries soil particles and crop residues. Significant numbers of pathogen spores maybe dispersed in this manner.

Dr David Nehl studied the distribution of spores of the black root rot pathogen in tailwater from an infested field and found 175 spores/litre of tailwater and 11,750 spores/kg of trash carried in tailwater at the tailwater drop-box. Trash carried in tailwater and sampled 2 km from the tailwater drop-box was found to be still carrying 2,671 spores/kg trash.

Figure 3.5.1. Aerial photo of Fusarium wilt showing spread of the pathogen down the furrows.

Aerial photographs of the field distribution of Fusarium wilt also show the significance of spore dispersal in irrigation water. The pathogen that causes Verticillium wilt can be easily isolated from crop residues floating in tailwater return systems.

Repeated wetting and drying cycles reduce pathogen survival

Pathogens survive best in dry soil. Frequent wetting and drying cycles allow for rapid breakdown of crop residues and consequently reduced survival of spores of the pathogen. Many cotton pathogens are favoured by a dry winter period between subsequent cotton crops.

Figure 3.5.2. Large amounts of crop residue are moved about in tailwater return systems.

Various types of 'trashlifter' have been developed to remove a significant proportion of the crop residues from the tailwater return system.

Minimising the impact of irrigation practices on the pathogen

Minimise tailwater and tailwater recirculation by pulling siphons earlier. It is not easy or convenient but it can be done! Less tailwater recirculation means less pathogen redistribution. It is impossible to eliminate stormwater run-off.

> *Trevor Brownlie of "Mahnal" Gibber Gunyah via Theodore writes: "Our irrigation strategy is to irrigate the whole field at once. We operate a two-metre permanent bed system in our Fusarium affected field and therefore only irrigate every second row across the field. However in the 50 to 60 metres of rows surrounding the diseased area we ensure that the siphons are pulled from the head ditch early so that no excess irrigation water reaches the tail drain. This practice has prevented the dispersal of soil particles and infected plant material via the tailwater system. Disease surveys conducted by the QDPI's Dr Joe Kochman have indicated to date that the disease has not spread outside the initial affected area. In addition – any field operation, such as planting, spraying or picking, start at either end of the field and work inwards to the affected area. The rows of the affected area are worked last, and machinery cleaned down before moving on to another part of the farm."*
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> (Note: When applying this strategy it is essential that the full distribution of the pathogen is known. It may be wiser to minimise tailwater across the whole farm!)

Minimise tailwater backing up into field. This may be achieved by modifying the depth and slope of taildrains and managing irrigations to minimise the volume of water in the tailwater return system.

Remove crop residues from tailwater return systems. Floating 'booms' may be used to hold back rafts of crop residue. Various designs of 'trashlifter' can be installed in the tailwater return system. The potential for natural wetland areas to act as 'biological strainers' is being evaluated.

Flood infested fields for 30-60 days in summer (summer flooding). If water is available and field topography is suitable then summer flooding is an option for reducing, but not eliminating, the pathogen spore population. This has been shown to be effective against black root rot and Fusarium wilt in Australia and is recommended for the control of seedling diseases, black root rot and Verticillium wilt in parts of California. The soil (and crop residues) must be completely submerged.

Consider CPLM or drip instead of furrow irrigation. Centre Pivot/Lateral Move (CPLM) and drip systems should not produce tailwater (from irrigation), therefore reducing the movement of disease causing pathogens from the field.

Beware of contaminated water sources. Run-off from a gin yard may introduce new pathogens. An outbreak of Phytophthora boll rot in California was attributed to the overhead application of water from an infested water storage. Water storages may become contaminated when used to store tail water from fields where a disease is present.

The impact of irrigation practices on the host

Diminished host plant resistance due to waterlogging-induced nutrient imbalances

Natural host plant resistance mechanisms are dependent on adequate host plant nutrition. Potassium is particularly important and potassium deficiency in cotton has been associated with increased susceptibility to Fusarium wilt, Verticillium wilt and Alternaria leaf spot.

Minimising the impact of irrigation practices on the host

Avoid or minimise waterlogging

Fields should have adequate slope and be well drained. Tail drains should be efficient and not allow adjacent areas of the crop to be inundated unnecessarily. For some soil types the use of wide (2metre) beds may provide an alternative system to minimise or reduce waterlogging. Owners of CPLM systems have noted decreased susceptibility to disease which they attribute to reduced waterlogging under these systems. Drip systems should have similar advantages.

The impact of irrigation practices on the crop environment

Irrigations drop soil temperatures

The pathogens that cause seedling diseases, black root rot, Fusarium wilt and Verticillium wilt are all favoured by cooler soil temperatures and adequate soil moisture.

High humidity and periods of leaf wetness favour infection

Foliar pathogens such as those responsible for bacterial blight and Alternaria leaf spot require either very high humidity or periods of leaf wetness for spore germination and completion of the infection process. In the dry Californian climate, the change from overhead sprinkler irrigation (which wet the leaves) to furrow irrigation (where leaves remained dry) provided complete control of bacterial blight. Whilst recent surveys of CPLM users in the Australian cotton industry have not identified an increased incidence of foliar disease under sprinklers, growers are advised to be vigilant as leaf wetness is likely to increase the potential for disease under certain conditions, particularly in wet seasons.

Late season irrigations contribute to later harvests

Later maturing crops are exposed to cooler autumn weather which is more favourable for disease development. Irrigations can contribute to fluctuating humidity in rank cotton which can lead to Sclerotinia outbreaks. This can happen when ideal weather conditions occur simultaneously with a particular plant growth stage (dying petals and leaves). Spores from the apothecia are forcibly ejected when relative humidity changes and can infect bolls and fruiting branches when dying petals and dead leaves get hung up in the canopy. Withholding the final irrigation to cotton fields in California resulted in a lower incidence of Verticillium wilt and a higher yield than in control fields that did receive the final irrigation.

Minimising the impact of irrigation practices on the crop environment

- Plant into moisture in preference to watering-up.
- Avoid late irrigations.
- Be vigilant for foliar disease outbreaks under sprinkler systems, particularly in wet years.

Conclusions

Irrigation strategies have contributed, and are still contributing, to the emergence of significant cotton disease problems that threaten the economic viability of cotton farming. Cotton plant breeders may eventually provide solutions to these disease problems in the form of resistant varieties but it could be a long time before that solution is forthcoming. In the meantime it is essential that growers do all they can to slow the rate of epidemic development by reducing the spread of pathogens, providing for the adequate nutrition of the host and by manipulating the crop environment so that it is less favourable for disease development.

Further reading

For further reading, see *Integrated Disease Management Guidelines*