Has Alternaria leaf spot become a major concern in your cotton fields?

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ALTERNARIA leaf spot (ALS) on cotton has become a major concern in recent years. ALS outbreaks were reported on seedlings in southern New South Wales (NSW) in the 2017–18 season (Figure 1), and thereafter a couple of mature cotton fields in Forbes were heavily infested with ALS in the 2018–19 season (Figure 2). The disease was observed again on seedlings across NSW during our early season survey in the 2019–20 season.

ALS symptoms start with pinhead necrotic lesions surrounded by a purple halo. Under favourable conditions, lesions continue to enlarge and coalesce to form irregular shapes. Severe infection may result in blight and desiccated cotyledons/leaves (Figure 3).

Historically, ALS was considered a minor issue in cotton production across Australia. But the disease has increased in prevelance in some cotton growing regions following a run of favourable season and conditions. Whether this increased prevalence correlates to yield is not yet known. In the early 2000s, ALS was prevalent (100% incidence) in trials in Northern Australia. Pima cotton is much more susceptible, and yield losses were insignificant, even in the absence of fungicide, as infection occured after crop cut out. Pima cotton is much more susceptible, and yield losses from ALS have been recorded on Pima cotton in other countries such as up to 40 per cent in Israel, 25–37 per cent in India, and 22–33 per cent in Zimbabwe.

Our pot trials revealed that cotton seedlings infected with ALS accumulated around 25 per cent less biomass compared to healthy control seedlings. Cotton is highly effective in compensating for leaf damages, particularly during seedling stages, but slow accumulation of biomass can translate into delayed maturity.

Further studies to determine the relationship between ALS of cotyledons and cotton yield under Australian conditions are required. In Australia, though yield loss caused by ALS have been considered economically insignificant, this needs reevaluation in the current climate, with new varieties and across various crop rotations.

It is warranted to continue to monitor ALS over multiple years to ascertain the impact of ALS on cotton yield and the cotton farming systems. Most studies have found that Pima cotton is more susceptible to ALS than upland cotton, but currently no Pima cotton cultivars are commercially available in Australia. So it is assumed that ALS pressure on upland cotton in Australia will be minimal. After recent outbreak events on upland cotton, it was questioned if these were associated with a different pathogen.

Alternaria leaf spot pathogens

We collected enough morphological, molecular and pathogenicity evidence to confirm that *Alternaria alternata* was the main causal pathogen responsible for recent ALS outbreaks on seedlings in southern NSW. *A. alternata* only became dominant later in the season when grown in northern Australia.

On the other hand, *A. macrospora* has been reported as a main causal agent of ALS on Pima cotton in Australia. Cotton cotyledons were also found more susceptible to *A. macrospora* infection. But these research findings were limited to Katherine in the Northern Territory where significant differences in climatic conditions compared with southern NSW are likely to influence ALS pathogen populations. *A. macrospora* has also been reported as the main ALS pathogen of cotton in Israel and India.

FIGURE 1: ALS on cotton seedlings in southern NSW – cotyledons were severely infected

FIGURE 2: A mature cotton field in Forbes was severely infested with ALS after a chilling event in the 2018–19 season

FIGURE 3: Severe infection of ALS resulted in desiccated cotyledons (A), and mature leaf (B)

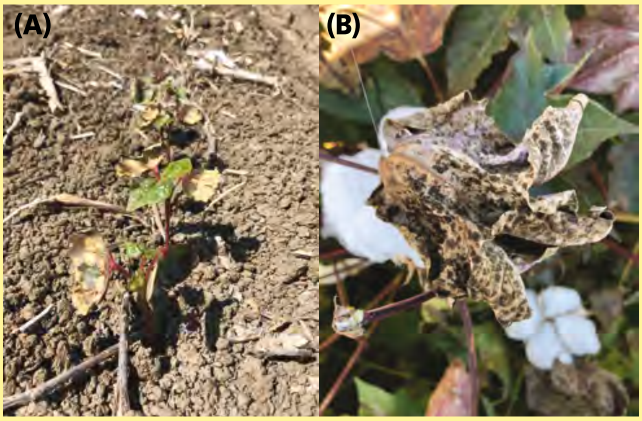
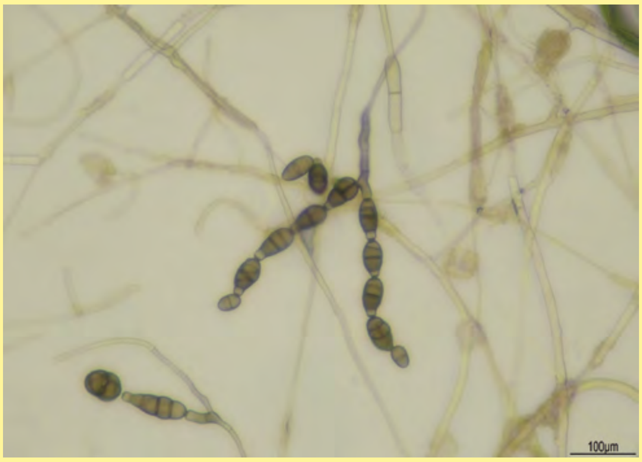


FIGURE 4: Typical chains of conidia of *A. alternata* produced on synthetic media



In Israel, severity of *A. macrospora* infection on Pima cotton was observed during wet summer months when temperatures were around 20 to 33°C, which did not align with usual growing conditions early in the season in southern NSW where average temperatures below 20°C were recorded in the 2017–18 season. But occurrence of ALS on upland cotton cotyledons in southern NSW were possibly due to the susceptibility to *A. macrospora*.

It has historically been considered that *A. macrospora* was more prevalent early in the season and declined significantly towards the end of the season. But in the past two seasons we have not recovered any isolates similar to *A. macrospora* morphologically and genetically. Instead, *A. alternata* was the main fungal pathogen recovered from ALS diseased cotyledons, leaves and bolls in the past two seasons. Additional data over multiple seasons are required for better understanding about the roles of *A. macrospora* and *A. alternata* on ALS of cotton in Australia.

Alternaria alternata belongs to section Alternata, which produces small spores (conidia) frequently in chains (Figure 4). Conidia are asexual reproductive structures and known as primary infection sources. Conidia are ovate to obclavate in shape, divided by transverse and vertical walls. Conidia with conical or cylindrical beaks range from 10 to 25 µm in length and 4 to 10 µm in width. *A. alternata* is a cosmopolitan saprophyte and pathogen.

Currently, seven pathotypes have been identified which differ in their production of host-selective toxins during conidia germination prior to penetration of the host plant. But pathotypes of the *A. alternata* which we recovered from cotton have not been identified and it is not known if it produces any toxins similar to the known ones. Such knowledge will provide insight into the pathogenicity of cotton *A. alternata* as well as towards selection of resistant lines.

Alternaria alternata is an airborne pathogen, but it can survive saprophytically in soil and plant debris. The pathogen has been frequently reported causing pre and post-harvest rot(s)/blight(s) of more than 100 host species. But strains with host specificity have also been recorded. Our in vitro study revealed that *A. alternata* had the optimal growth temperature at 25°C, but it can grow in a wide range of temperature from 5–35°C. This growth pattern was highly similar to *A. alternata* isolates recovered from cotton in New Mexico, USA. Interestingly, in our bioassays conducted on detached cotton leaves, the *A. alternata* appeared more virulent at 20°C than it did at 25°C.

Other researchers also found that cotton plants which experienced short-term pre-chilling stress at the temperature between 8–20°C were more prone to infection and damage of *A. alternata* compared with those grown at 20–28°C. In Australia, we also noticed that ALS on cotton often occurred more prevalent after chilling events such as heavy dew or rainfall. But the infection and severity of ALS on cotton are also highly dependent on inoculum loads and susceptibility of the cotton host. Such knowledge is essential for ALS management, but little is known.

Management

Like many other diseases, successful management of ALS on cotton requires an integrated approach pre, during and post growing season. Good field preparation by removing trashes, alternative hosts and volunteer cotton will help to reduce primary inoculum sources. Adoption of good tolerant/resistant cultivars is also common practice to manage ALS, but there are relatively sparse data on the susceptibility of current commercial upland Australian cotton germplasms to ALS caused by *A. alternata*. A number of fungicides are registered against *A. alternata* on horticultural crops. But ALS has been long considered a minor disease of cotton in Australia, so there are no registered fungicides for use in cotton.

An emergency permit was granted for use of mancozeb and tebuconazole in response to the outbreak of ALS in southern NSW in 2017–18. We recommend that care should be taken with fungicide applications since *A. alternata* is prone to develop fungicide resistance and late season yield impact has still not been proven. Our initial in vitro assessments found that *A. alternata* was less sensitive to a couple of tested fungicides than we expected. CRDC and NSW DPI are currently funding a project (DAN1703-Innovative Solutions to Cotton Diseases) to search for alternative control options against some major cotton diseases. Given the uncertainty about yield, we are also planning research to address whether control is warranted.

The ALS disease is a high priority. We are working with chemical suppliers to assess a number of fungicides as well as novel compounds for their in vitro control efficacy against *A. alternata*. In collaboration with Tim Green, a southern based cotton pathologist, we will further assess a number of promising candidates under field conditions at Yanco research station. *A. alternata* can survive saprophytically on crop residues, therefore burying ALS infected residue could accelerate decomposition and subsequently reduce inoculum loads.