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# SEED TREATMENTS TO INDUCE RESISTANCE TO FUSARIUM WILT AND BLACK ROOT ROT IN COTTON

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## Abstract

Fusarium wilt and black root rot are important diseases of cotton in Australia. These diseases are having a significant impact on the health of cotton seedlings soon after emergence. Previous studies have shown that foliar applications of acibenzolar-S-methyl could induce a systemic resistance and provide some control of other foliar and vascular diseases of cotton. However, the pathogens that cause Fusarium wilt and black root rot infect soon after emergence and before foliar applications are practical. The incidence of Fusarium wilt and the severity of black root rot were significantly reduced when acibenzolar-S-methyl was applied to seed prior to sowing. While not providing complete control, systemic induced resistance is seen as a potentially important component of an integrated disease management strategy for Fusarium wilt and black root rot of cotton.

## Introduction

Fusarium wilt (caused by *Fusarium oxysporum* f.sp. *vasinfectum*) and black root rot (caused by *Thielaviopsis basicola*) are important and widespread diseases of cotton in Australia. Nehl et al. (2003) estimated that Fusarium wilt could be on 90% of farms in NSW by 2010 if the current rate of spread is maintained. Black root rot is already present on 97% of farms visited in annual disease surveys in NSW and has been found in 72% of fields inspected (Nehl et al., 2004). These diseases are having a significant impact on the health of cotton seedlings soon after emergence.

Colson-Hanks et al., (2000) showed that foliar applications of acibenzolar-S-methyl (ASM) can induce a a degree of systemic resistance and provide some control of Alternaria leaf spot, bacterial blight and Verticillium wilt of cotton. With black root rot and Fusarium wilt of cotton in Australia, severe symptoms may develop within a few weeks of planting and before foliar applications are practical. Previous studies by Zeringue and Shih (2000) demonstrated that the treatment of cotton seeds prior to sowing with various products induced the production of numerous compounds in 7-day-old seedlings. Some of these compounds were found expressing persistent inducement in leaf tissue of mature leaves and contributing to significantly reduced aflatoxin formation in artificially inoculated cotton seeds of the mature experimental plants. We examined the potential to use ASM as a pre-sowing seed treatment for the control of Fusarium wilt and black root rot in cotton.

## Materials and Methods

ASM was applied to cotton seed by one of three methods: (i) ‘seed soaking’, whereby seed was immersed in a solution of ASM (25 ppm) for three hours, followed by air drying prior to sowing; (ii) ‘seed treatment’, in which ASM solution (300 mg/L) was applied evenly to cotton seed at the rate of 20 mL solution/kg seed; (iii) an ‘in-furrow’ spray, whereby ASM solution was applied as a spray over the seed at the rate of 25 g ASM per hectare during the planting operation. All experiments used a randomised complete block design with four to six replications.

### Black Root Rot

Three experiments were conducted in fields that were heavily infested with *T. basicola*. Seed soaking was used at a site near Narrabri while the in-furrow spray method was used at a site near Moree and seed treatment was evaluated at a site near Wee Waa.

The severity of black root rot was assessed five weeks after sowing by estimating the proportion of blackened tap root on a scale from 0-10. In the experiment at Moree the number of relatively healthy lateral roots, taken as those that had less than 50% of their length discoloured or blackened, was counted on each plant assessed. Fruit development, in the Moree experiment, was assessed by counting the number of bolls along two metres of row in each plot, in late January.

### Fusarium Wilt

Nine field experiments were established over four seasons at Fusarium wilt-affected sites in northern NSW and on the Darling Downs of Queensland. Plant stand was assessed soon after emergence and at the end of the season when the stems of plants were cut at ground level and inspected for vascular discoloration. Seedling survival indicated the proportion of the initial stand that survived the seedling phase of the disease while survival to maturity was a measure of the proportion of the initial plant stand that survived with little or no infection throughout the whole season.

## Results

The severity of black root rot on tap roots was reduced in all three experiments (Table 1). The number of relatively healthy lateral roots was increased 350% by ASM at the Moree site (Table 1) but was not significant at the Narrabri site (data not presented). ASM increased fruit development by 30% at the Moree site (Table 1). The application of ASM to cotton seed prior to sowing consistently reduced the incidence of Fusarium wilt (Table 2). The benefits of these pre-sowing applications of ASM was apparent throughout the season with significant reductions in the incidence of Fusarium wilt still apparent at crop maturity.

## Discussion

While not providing complete control, systemic induced resistance is seen as a potentially important component of an integrated disease management strategy for Fusarium wilt and black root rot of cotton. The application of ASM to seed prior to sowing appears to induce a defence response in cotton that is effective against soil-borne pathogens that have different infection courts. *T. basicola* affects the root cortex while *F. oxysporum* f.sp. *vasinfectum* colonises the vascular tissue.

In the initial experiments ASM was applied to the seed by seed soaking. Since seed soaking would generally not be convenient for on-farm use of the product the later experiments evaluated the use of ASM as an in-furrow spray or as a seed treatment. Field experiments now in progress are investigating the efficacy of ASM as a seed treatment when applied up to three months before sowing.

## Acknowledgements

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## References

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Table 1. Reduced severity of black root rot of cotton in the field following treatment of seed with acibenzolar-S-methyl (ASM) prior to sowing.

| Experiment location/season | Treatment method | Disease severity (0-10 scale) | | Prob. | Lateral roots (no./plant) | | Prob. | Fruiting (bolls/metre) | | Prob. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Control | ASM | | Control | ASM | | Control | ASM | |
| Narrabri 01/02 | Seed soaking | 6.9 | 4.6 | $p$=0.021 | - | - | - | - | - | - |
| Moree 01/02 | in-furrow spray | 9.6 | 7.4 | $p$<0.001 | 1.5 | 6.8 | $p$<0.001 | 21 | 27 | $p$=0.004 |
| Wee Waa 03/04 | Seed treatment | 6.6 | 5.3 | $p$<0.001 | - | - | - | - | - | - |

Table 2. Increased survival of cotton following treatment of seed with acibenzolar-S-methyl (ASM) in nine field experiments over four seasons in Fusarium wilt-affected crops in NSW and Queensland.

| **Experiment location/season** | **Treatment method** | **Seedling survival (%)** | | | **Survival to maturity (%)** | | |
|---|---|---|---|---|---|---|---|
| | | **Control** | **ASM** | **Prob.[z]** | **Control** | **ASM** | **Prob.[z]** |
| Boggabilla 99/00 | Seed soaking | 42 | 73 | $p$<0.001 | - | - | - |
| Pampas 00/01 | Seed soaking | 90 | 92 | n.s. | 58 | 74 | $p$<0.001 |
| Pampas 01/02 | Seed soaking | 28 | 60 | $p$<0.001 | 3.2 | 12 | $p$=0.011 |
| Pampas2 01/02 | Seed soaking | 23 | 48 | $p$<0.001 | 1.4 | 4.7 | $p$<0.001 |
| Brookstead 01/02 | Seed soaking | 49 | 82 | $p$<0.001 | 26 | 49 | $p$<0.001 |
| Boggabilla 01/02 | Seed soaking | 64 | 79 | $p$<0.001 | 22 | 25 | n.s. |
| Melrose 01/02 | Seed soaking | 49 | 63 | $p$<0.001 | 9.4 | 15 | $p$=0.004 |
| Pampas 02/03 | In-furrow spray | 84 | 99 | $p$=0.004 | 60 | 75 | $p$<0.001 |
| Boggabilla 02/03 | Seed treatment | 78 | 86 | $p$=0.010 | 24 | 33 | $p$=0.001 |

[z]All trial results subjected to analysis of variance using Genstat v6.1 spatial (REML) analysis. n.s. = not significant.