2011 Field Evaluation of a Seed Treatment That Induces Resistance to Thelaviopsis basicola in Cotton

Dr. Stephen J. Allen , CSIRO - Australian Cotton Research Institute, Narrabri, Australia

AUTHOR: Stephen J. Allen
Cotton Seed Distributors Ltd.
Australian Cotton Research Institute
Narrabri, NSW, Australia 2390
Stephen.Allen@csiro.au
Phone 61 2 67 991 500

ABBREVIATION ASM – Acibenzolar-S-methyl

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ABSTRACT

The results of annual disease surveys of commercial cotton (*Gossypium hirsutum*) crops in all production areas of New South Wales indicate that black root rot, caused by *Thielaviopsis basicola*, has become the most widespread and common disease of cotton in the state. No single strategy or treatment has provided adequate or consistent disease control. The use of Acibenzolar-S-methyl as a seed treatment applied at a rate of 6mg active ingredient per kilogram of seed has been shown to induce resistance to the pathogen and reduce disease severity. The efficacy of this seed treatment was evaluated in 23 large scale field experiments over two seasons. Disease severity as indicated by the proportion of the taproot that was blackened, was significantly reduced in 17 of the 23 experiments. The seed treatment was most effective in seedlings subjected to moderate disease pressure and least effective in seedlings exposed to very high disease pressure. In the absence of any host plant resistance in *G. hirsutum* the use of Acibenzolar-S-methyl is seen as a valuable component of an integrated disease management strategy.

KEYWORDS: Acibenzolar-S methyl, Acquired resistance, Benzothiadiazole, Bion®, Black root rot, Systemic induced resistance

Introduction

Black root rot of cotton (*Gossypium hirsutum* L.) is caused by *Thielaviopsis basicola* (Berk. & Br.) Ferraris and was first observed in cotton in Australia in 1989 (Allen, 1990). The distribution, incidence and importance of diseases of cotton are monitored by annual surveys of commercial cotton crops across all production areas in NSW, Australia. Nehl et al. (2004) reported that the disease had been found on 36% of plants in 72% of fields on 97% of farms visited during the 2003 survey. Black root rot of cotton has now been confirmed as present in all cotton production regions in Eastern Australia (Allen, 2006). It was suggested that this exponential spread of the pathogen had been facilitated by a repetitive cotton monoculture and movement of the pathogen in flood and irrigation water and in soil and crop residues attached to vehicles and machinery (Nehl et al., 2004)

Infection by *T. basicola* results in a blackening of the tap root, restricted development of secondary roots, very slow seedling growth and delayed maturity. The disease does not kill plants. Yield losses are most likely in short season areas where affected plants do not have sufficient time to compensate for their slow development early in the season (Nehl et al., 2004).

No evidence of host plant resistance to *T. basicola* has been found in *G. hirsutum* and current control options are limited to crop rotation with non hosts, biofumigation with a green manure crop of vetch, summer flooding and delaying the sowing time to avoid cool conditions that favor the disease early in the season. Those fungicide seed treatments and in-furrow treatments that have been evaluated have provided either inconsistent or inadequate control (Allen, 2004, 2006; Nehl et al., 2004).

Initial studies by Mondal et al. (2005) showed that the use of a treatment that induced systemic resistance could have some potential for controlling black root rot. They evaluated foliar sprays, in-furrow sprays, seed soaking and seed dressing applications of Acibenzolar-S-methyl (ASM) to cotton seed or seedlings. The application of ASM by either seed soaking or seed treatment has also provided significant control of Fusarium wilt of cotton caused by *Fusarium oxysporum* f.sp. *vasinfectum* (Allen et al.,2004). ASM (BTH or Benzothiadiazole) is supplied by Syngenta Crop Protection as Bion® Plant Activator Seed Treatment with active constituent 500g/L Acibenzolar-S-methyl. Mondal et al. (2005) reported significant reductions in the severity of black root rot on cotton tap roots as a result of the use of ASM in controlled environmental experiments and a small scale field experiment. Considerable effort has been devoted to a comparison of application techniques and the establishment of optimal rates (Mondal et al., 2005; Driessen et al., 2006). Several large scale field experiments evaluating the efficacy of ASM as a seed treatment for the control of *T. basicola* were completed in the 2005/06 season with encouraging results (Driessen et al., 2006).

The purpose of the work reported here was to add the results of a second year of large scale field evaluations using commercial scale seed treating equipment to apply the ASM to the seed.

Materials and Methods

Large scale field experiments with an unregistered product were conducted with approval from the Australian Pesticides & Veterinary Medicines Authority under Permit PER8332 in 2005/06 and Permit PER9189 in 2006/07.

All seed treatments were applied at the Cotton Seed Distributors Ltd. 'Shenstone' facility at Wee Waa in NSW, Australia. The standard fungicide seed treatment (Dynasty® from Syngenta Crop Protection) was applied to all seed used in the experiments. Different seed colors were used for the Control and ASM treated seed to allow verification of the experimental design after planting. ASM was applied at 6mg ai / kg seed. All field experiments were located on farms in North-West NSW.

Cotton growers that collaborated in these experiments in the 2005/06 season were able to select the cultivar of their choice and specify whether or not they added an insecticide seed treatment. Plot size was determined by the length of the field (400m to 1100m) and the width of farm machinery (8 rows or 12 rows). Growers were only supplied with sufficient seed for an experiment with either six or eight replicates of each of the control and ASM treatments. The treatments were applied to the seed using a cement mixer with a batch size of 20kg.

In the 2006/07 season cotton growers were limited to a choice of just five cultivars and all seed choices were supplied with the insecticide Cruiser® from Syngenta Crop Protection. Growers were able to order sufficient seed treated with ASM for the whole field with only enough untreated seed provided to allow an experiment with either six or eight replicates. Treatments were applied to the seed with a 'Sprout Matador' continuous feed seed treater.

Field selection, ground preparation, irrigation, selection of the sowing date, seed rate and herbicide applications were according to standard commercial practice and at the discretion of the cooperating grower.

Disease severity was assessed as near as possible to 21 days after sowing. Either 10 or 20 randomly selected seedlings were carefully removed from the ground in each plot using an asparagus knife. Attached soil was shaken free and the proportion of the tap root that had become blackened was assessed using a 0 to10 scale where 0 indicated no apparent disease symptoms and 10 indicated 100% of the tap root blackened.

Results

The trial location as indicated by the farm name and sowing date, plot size, number of replications, timing of disease assessment, disease severity and statistical significance are presented in Table 1. The ASM seed treatment significantly reduced the severity of black root rot symptoms on the tap root in 17 of the 23 experiments. It should be noted that ten of the field experiments in the 2005/06 season were sown prior to 5th October while only three experiments were sown after this date. In the 2006/07 season only one experiment was planted prior to 5th October while six experiments were sown after that date. Delaying the sowing date usually results in warmer conditions at sowing and consequently more rapid seedling emergence and reduced disease severity.

Disease severity, which reflects both the population of the pathogen present in the soil and the favorability of the environment, varied from 4.6% to 98.7% of the tap root blackened The relative reduction in black root rot severity resulting from the use of ASM is presented in relation to disease pressure at the site of each experiment (Figure 1). There is a clear relationship between disease pressure and the efficacy of the ASM seed treatment.

ASM appears more effective when disease pressure is moderate and less effective under high disease pressure.

Discussion

Black root rot has rapidly spread throughout Australian cotton production regions and causes considerable concern early in the season when seedlings are stunted and crop development is slow. In most areas and in most seasons the cotton crop is able to compensate in autumn and yield losses are minimal, however, yield losses could be more substantial in shorter season production regions. As a soilborne pathogen with a wide host range and a capacity to survive and be readily dispersed around the farm *T. basicola* is very difficult to control. No single effective strategy has yet been identified.

The results of large scale field experiments have shown that the use of Acibenzolar-S-methyl as a seed treatment can induce an increased level of resistance to *T. basicola* in cotton. While this increased resistance does not provide complete control by itself it can be considered as a valuable component of an Integrated Disease Management Strategy and combined with sowing at warmer soil temperatures provide a greater level of control.

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Table 1. The effect of seed treatment with Acibenzolar-S-methyl on the severity of black root rot on cotton seedlings in 23 large scale field experiments over two seasons.

					Disease severity (0-10)		
Location	**Sowing date**	**Plot width[z]**	**Reps.**	**Assessed[y]**	**Control**	**ASM[x]**	**F- test.[w]**
Redbank	**27 Sept'05**	**12 rows**	**8**	**22 das**	**2.9**	**2.2**	***P*=0.003**
Killarney 1	**27 Sept'05**	**8 rows**	**6**	**27 das**	**9.7**	**9.0**	***P*=0.003**
Killarney 2	**27 Sept'05**	**8 rows**	**6**	**27 das**	**9.6**	**9.2**	**NS**
Wild Will.10	**1 Oct'05**	**8 rows**	**8**	**24 das.**	**6.9**	**4.4**	***P*<0.001**
Deer Park	**2 Oct'05**	**12 rows**	**6**	**24 das**	**8.7**	**8.4**	**NS**
Glendara	**3 Oct'05**	**12 rows**	**6**	**22 das**	**7.2**	**5.1**	***P*=0.002**
Eureka	**3 Oct'05**	**12 rows**	**6**	**23 das**	**6.3**	**4.1**	***P*=0.041**
Aminya	**4 Oct'05**	**8 rows**	**6**	**20 das**	**8.4**	**7.0**	***P*=0.003**
Belapais	**4 Oct'05**	**8 rows**	**8**	**21 das**	**6.6**	**5.9**	**NS**
Glen Prairie	**4 Oct'05**	**8 rows**	**6**	**23 das**	**5.6**	**4.8**	***P*<0.001**
Woodbine	**5 Oct'05**	**8 rows**	**6**	**21 das**	**8.6**	**8.1**	**NS**
Tarrawatta	**5 Oct'05**	**8 rows**	**6**	**22 das**	**0.5**	**0.5**	**NS**
Sth Colmlee	**6 Oct'05**	**8 rows**	**8**	**20 das**	**7.7**	**6.5**	***P*=0.018**
Wild Will.8	**7 Oct'05**	**8 rows**	**8**	**21 das**	**9.0**	**7.8**	***P*=0.020**
Warilea	**25 Oct'05**	**12 rows**	**8**	**20 das**	**7.5**	**6.1**	***P*=0.001**
Laurella	**25 Sept'06**	**8 rows**	**8**	**22 das**	**5.3**	**3.0**	***P*=0.008**
Beela	**5 Oct'06**	**8 rows**	**8**	**20 das**	**1.8**	**1.1**	***P*=0.036**
Merinda	**7 Oct'06**	**8/16 rows**	**8**	**20 das**	**4.4**	**2.1**	***P*=0.001**
Eagle Farm	**9 Oct'06**	**8 rows**	**6**	**32 das**	**2.0**	**0.6**	***P*=0.029**
Havana	**10 Oct'06**	**8/16 rows**	**8**	**29 das**	**3.9**	**2.1**	***P*=0.003**
Waiwera	**18 Oct'06**	**8 rows**	**8**	**21 das**	**2.5**	**1.1**	**NS**
Delblair	**20 Oct'06**	**8 rows**	**6**	**21 das**	**7.8**	**6.5**	***P*=0.015**
Killarney	**23 Oct'06**	**1row x30m**	**6**	**25 das**	**9.9**	**8.1**	***P*<0.001**

[Z] – Plot length was length of field (400m to 1000m) unless otherwise indicated

[Y] – Assessments of black root rot severity were done at 20 to 32 das (= days after sowing)

[X] – ASM = Seed treatment with Acibenzolar-S-methyl at 6mg ai / kg seed

[W] – *P*-values. NS = Not significant

Figure 1. The reduction in the severity of black root rot of cotton seedlings resulting from the use of Acibenzolar-S-methyl as a seed treatment in large scale field experiments over two seasons.