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APPLICATION OF PESTICIDES TO CONTROL FUSARIUM HARDLOCK OF COTTON IN FLORIDA

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Abstract

Fusarium hardlock is a frequent problem in the Southeast which can result in large yield losses. Previous studies have shown it to be associated with *Fusarium verticillioides*. Fungicide applications during bloom have been shown to reduce the problem. This study investigated the role of fungicide and insecticide applications in reducing hardlock and increasing yield. Flower thrips may contribute to hardlock, and significant control was obtained with insecticide applications. Insecticides applications significantly reduced hardlock in all instances. Fungicides were effective in most cases. When significant yield improvements were attained, it was usually due to insecticide applications alone or in conjunction with fungicides.

Introduction

Hardlock of cotton is characterized by a failure of the fiber to expand outward from the locules after boll opening. These locules sometimes have a slightly pink appearance due to the presence of *Fusarium verticillioides*. Although fiber quality is not severely reduced, affected locules cannot be picked using conventional spindle picking equipment. The result is yield loss varying from 20-70%. Fusarium hardlock is believed to result from infection by *F. verticillioides* at the time of bloom (Marois, et al, 2002, Marois and Wright, 2003, Wright, et al, 2004). Previous studies have shown the application of fungicides during bloom may provide a reduction in hardlock severity (Seebold, et al, 2004).

It has been suggested flower-inhabiting thrips, particularly *Frankliniella tritici*, which are widespread in the Southeast could increase the severity of hardlock. Thrips feeding results in tissue damage, which could allow the pathogen to more easily infect the flower. Previous research, conducted in both Quincy and Marianna, FL, has shown that thrips numbers can be reduced using insecticides in a field setting (Mailhot, et al, 2005). The resulting impact on hardlock and yield was not reported, but is included here.

The objectives of this study were to quantify the impact of insecticide and fungicide sprays during bloom period on leaf area, thrips numbers, hardlock, and yield.

Materials and Methods

Field Plots

Studies were conducted at branches of the North Florida Research and Education Center in Quincy and Marianna, Florida. DPL 555 Bt/RR was used, providing resistance to glyphosate herbicide and producing the *Bacillus thuringiensis* endotoxin. The crop was maintained according to the recommendations of the University of Florida unless otherwise noted. Orthene and Karate were used when needed to control the southern green stinkbug and the brown stinkbug. In Quincy, the studies were conducted on a Dothan sandy loam (fine loamy siliceous thermic Plinthic Kandiudult). The study in Marianna was conducted on a Chipola loamy sand (fine loamy siliceous thermic Plinthic Kandiudult).

Effect of Fungicides on Leaf Area, Fusarium Hardlock and Yield

A randomized complete block design was used with 4 blocks and 10 treatments (Table 1). Plots were 4 rows (36 in between rows) by 30 ft long. The fungicide treatment receiving insecticide applications consisted of 2.9 oz/acre of Tracer on Mondays and 8 oz/acre + 2 oz/acre on Thursdays. Leaf area was determined with a Licor 2000 Plant Canopy Analyzer, which allowed for non-destructive sampling. Hardlock severity was assessed on 10/17/2005, approximately 2 weeks after defoliation. Five plants were selected at random, and the number of hardlocked and total locules per boll was recorded for each plot. This data was used to calculate both the hardlock severity and number of bolls per plant. The two center rows of each plot were harvested f with a spindle plot picker or yield.

Effect of Fungicides and Insecticides on Thrips, Hardlock, and Yield

Control and insecticide or insecticide+fungicide plots within the Quincy study were sampled for thrips, depending on the year. In each of the 8 plots, 12 flowers were collected weekly, and stored in isopropyl alcohol for identification. Hardlock and yield data was recorded as part of the larger fungicide study described previously.

A randomized complete block design was used in Marianna, Florida with 4 block and 4 treatments. Plots were 6 rows (36 in between rows) by 30 ft long. The experiment included unsprayed control plots and three other treatments which were applied during the bloom period. The insecticide treatment consisted of Tracer at 2 oz/acre alternated weekly with Orthene at 1 lb/acre. The fungicide treatment consisted of Topsin M at 1.25 lb/acre applied weekly. A fourth treatment included both the weekly insecticide and fungicide sprays listed above. Flowers were sampled weekly, 8 from each plot, and stored in isopropyl alcohol until thrips could be counted. Hardlock and yield were determined as described for Quincy.

Population survey of cotton flowers

Fifteen flowers were sampled at 2-hour intervals from cotton plots in Quincy, FL, to determine the change in number of thrips within flowers during the day. This was repeated on 5 different days, from 10:00 to 18:00. Samples were not taken earlier in the day since the flowers did not open until between 9:00 and 9:30. Dissection of unopened flowers did not reveal any thrips present. The samples from the Marianna study discussed previously were also examined for *Orius sp*. (minute pirate bug), *Aphis sp*. (aphids), and *Solenopsis sp*. (ants).

Isolation of Fusarium from thrips

Thrips were captured as described in Mailhot, et al, 2005. This was performed for 3 years, and permitted an assessment of the proportion of flowers which contained thrips that were carrying *F. verticillioides*.

Results

Effect of Fungicides on Leaf Area, Fusarium Hardlock and Yield

Leaf area index was significantly affected by fungicide treatments (Table 1). More applications particularly those occurring at the end of the season provided the most benefit. Hardlock was significantly reduced by fungicides, particularly in conjunction with insecticides. The differences in number of bolls per plant were significant, but not consistent. Yield was not significantly affected, with controls at over 1500 lbs/acre.

Table 1. Effect of fungicicides on leaf area, Fusarium hardlock, and yield in 2005.

	Week of Bloom											
Treatment	1	2	3	4	5	6	7	Boll opener	Leaf Area Index	Percent Hardlock	bolls per plant	Lint Yield (lb/acre)
control									3.45	31.7	11.3	1547
control								3 dates	3.81	24.8	11.8	1581
Topsin 16 fl oz	X		X						3.65	30.9	10.8	1365
Topsin 16 fl oz	X		X		X				3.85	27.9	11.5	1545
Topsin 16 fl oz	X	X	X	X					3.39	31.8	12.7	1437
Topsin M 1.0 lb	X		X		X		X		3.94	24.1	10.0	1589
Topsin M 1.25 lb	X	X	X	X	X	X		3 dates	3.70	24.5	12.0	1421
Topsin M 1.25 lb	X	X	X	X	X	X			4.20	25.1	14.1	1513
Headline 12 fl oz (H) OR Topsin 1lb (T) OR Folicur 7.2 oz (F)	H	T	F	H	T	F			3.56	27.8	10.8	1395
Topsin M 1.0 lb + insecticide*	X		X		X		X		3.35	17.7	13.6	1590

Least Significant Difference at p <0.05	0.68	7.5	3.3	NS

*Insecticide – each week Tracer at 2.9 oz/A was applied on Monday and Orthene at 8 oz/A + Karate at 2 oz/A were applied on Thursday.

Effect of Fungicides and Insecticides on Thrips, Hardlock, and Yield

In the study at Quincy described above, thrips were counted in the flowers of selected treatments (Table 2). The use of insecticide, whether alone or with a fungicide, significantly reduced thrips numbers. Significant reductions in hardlock severity were obtained in 2005, but not 2004. Yield was not significantly affected.

Table 2. Effect of fungicides and insecticides on thrips, hardlock, and yield in Quincy, FL.

Treatment	thrips		hardlock		yield	
	2004	2005	2004	2005	2004	2005
Control	6.10 a	4.18 a	0.48 a	0.32 a	1369 a	1547 a
Insecticide +fungicide	---	0.32 b	0.42 a	0.18 b	1530 a	1590 a
Insecticide	0.95 b	---	0.42 a	---	1280 a	---

In Marianna, insecticides provided significant reductions in thrips number for all years (Table 3), while fungicides predictably had no impact. Insecticide significantly reduced hardlock in all years. Fungicide applications were significant in some years, but not all. Combining applications of insecticide and fungicide did not provide additional reductions in hardlock. Yields were low in 2003, and spraying was not beneficial. Yields were higher in 2004, and only the combined sprays resulted in a significant improvement. In 2005, yields were higher than previous years, and insecticide applications provided significant increases in yield.

Table 3. Effect of fungicide and insecticide treatments on thrips, hardlock, and yield in Marianna, FL.

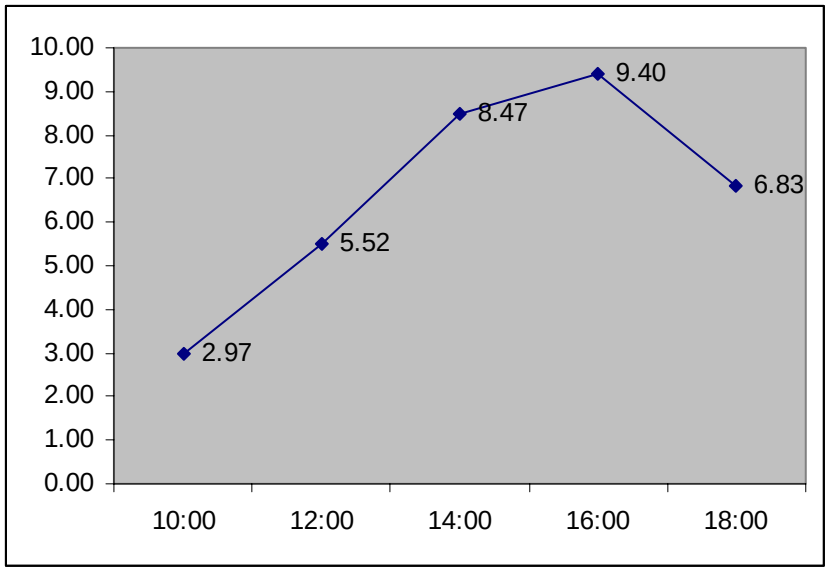
Treatment	thrips		
	2003	2004	2005
Control	4.05 a	3.28 a	1.68 a
Fungicide	3.84 a b	2.96 a b	1.79 a
Insecticide +fungicide	3.14 c b	2.38 b	1.16 b
Insecticide	2.83 c	2.59 b	1.08 b

Treatment	hardlock			yield		
	2003	2004	2005	2003	2004	2005
Control	0.72 a	0.41 a	0.41 a	528 a b	911 b	1276 b
Fungicide	0.69 a	0.31 b	0.33 b	533 a	1003 a b	1237 b
Insecticide +fungicide	0.52 b	0.28 b	0.23 c	417 b	1178 a	1688 a
Insecticide	0.47 b	0.29 b	0.19 c	499 a b	1110 a b	1602 a

Population survey of cotton flowers

In the study at Quincy, differences were observed in the average number of thrips per flower depending on the time of day (Figure 1). A peak in populations was encountered at 16:00, although it was not significant from other afternoon samplings. The mean numbers of various flower inhabitants encountered in the Marianna study are listed (Table 4). *F. tritici* was far more abundant than any other thrips species. Its sex ratio was stable throughout the study, but the numbers declined with each season. However, their numbers remained fairly constant within each season (data not shown).

Figure 1. Thrips per flower throughout the day.



Least Significant Difference at p <0.05 is 3.21

Table 4. Mean number of inhabitants per flower across all treatments in Marianna, FL.

Thrips		2003		2004		2005	
Juvenile		0.105		0.048		0.017	
Adult		Male	Female	Male	Female	Male	Female
	Frankliniella tritici	1.097	3.206	0.677	2.099	0.397	1.035
	F. fusca	0	0.016	0	0.009	0	0.005
	F. occidentalis	0.002	0.002	0.002	0	0	0
	F. bispinosa	0.010	0.065	0.002	0.014	0	0
	Thrips palmi	0.001	0.003	0	0	0	0
Other insects observed							
Juvenile	*Orius sp.*	0.061		0.036		0.035	
Adult	*Orius sp.*	0.104		0.051		0.147	
	Aphis sp.	1.204		1.829		5.476	
	Solenopsis sp.	0.095		0.291		0.252	

Isolation of Fusarium from thrips

There were no significant differences between years in the number of thrips between seasons (Table 5).

Table 5. Proportion of flowers containing thrips-carried Fusarium

Year	Percent Fusarium	N
2003	7.0 a	329
2004	13 a	23
2005	6.6 a	273

Discussion

Fungicides and insecticides both appear to be useful in management of hardlock. Despite this, they do not eliminate the problem entirely. In the studies presented here and others, hardlock severity tends not to drop below 15-20%. Hardlock was less severe in 2005, probably due to climate conditions. However, there was a much larger reduction in the number of locules displaying pink coloration due to *F. verticillioides*. It is possible that below 15-20% severity, the symptom of compact locules results from another cause or is a natural feature of the plant.

Acknowledgements

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