STATUS OF BOLLWORM, *HELICOVERPA ZEA*, SUSCEPTIBLILTY TO PYRETHROIDS IN THE MID-SOUTH AND SOUTHEAST: IRAC-US 1999 UPDATE

S. H. Martin, Zeneca Ag Products / IRAC-US
J. S. Bacheler, North Carolina State University
R. D. Bagwell, Louisiana State University
M. L. Boyd, University of Missouri - Delta Center
B. L. Freeman, Auburn University
G. A. Herzog, University of Georgia
D. R. Johnson, University of Arkansas
M. B. Layton, Mississippi State University
B. R. Leonard, Louisiana State University
N. Liu, Auburn University
G. T. Payne, State University of West Georgia
P. V. Pietrantonio, Texas A & M University
M. E. Roof, Clemson University
R. Seward, University of Tennessee
R. K. Sprenkel, University of Florida
M. J. Sullivan, Clemson University
J. W. Van Duyn, North Carolina State University
J. R. Weeks, Auburn University

Abstract

In 1999, IRAC-US sponsored a bollworm monitoring program to determine if a widespread change in the susceptibility of the bollworm to the pyrethroid insecticides is occurring. Bollworm moths were collected and tested in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Tennessee and Texas. Over 7,400 moths were bioassayed from May through October 1999. Survival at the 5 µg/vial dose of cypermethrin ranged from a low of 0% to a high of 34% in Missouri during June. Five states, Alabama, Louisiana, Missouri, North Carolina and South Carolina had greater than 10% survival during at least one month. Louisiana had greater than 10% survival at the 5 µg/vial dose from May through August. Survival at the 10 µg/vial dose of cypermethrin ranged from 0% to a high of 25% in South Carolina during June. Three collections: Louisiana (July), Missouri (June) and South Carolina (June) exceeded 15% survival at the 10 µg/vial dose. The increasing tolerance of the bollworm to the pyrethroids demonstrated in this study, suggest that maintaining the effectiveness of the pyrethroids against the bollworm should become a higher priority in future resistance management plans.

Introduction

The bollworm, *Helicoverpa zea*, is one of the most important pests of cotton and it has been documented to have developed resistance to several classes of insecticides (Sparks 1981). Several studies in recent years have reported bollworm populations that have developed tolerance or resistance to the pyrethroid insecticides (Abd-Elghafar et al. 1993, Kanga et al. 1996, Brown et al. 1998, Walker et al. 1998, Martin et al. 1999). In 1996 neurophysiological assays found a low frequency of pyrethroid target-site resistant bollworms in Louisiana (Holloway et al. 1997). Also, a long term monitoring program in Louisiana seems to indicate a gradual change in the susceptibility of bollworm to the pyrethroid insecticides (Bagwell et al. 1998).

The Insecticide Resistance Action Committee - United States (IRAC-US) is an inter-company committee dedicated to prolonging the effectiveness of insecticides and acaricides by countering resistance problems. The IRAC-US committee increases awareness of resistance through various educational programs and sponsors research to promote the prevention or management of insecticide resistance. During our 1998 meeting to review research proposals submitted for funding, we reviewed several proposals to evaluate various aspects of bollworm resistance to the pyrethroids. Since there was a high level of concern across the cotton belt about possible bollworm resistance to pyrethroids, IRAC-US thought it would be prudent to first find out if there was a widespread change in the bollworm susceptibility to the pyrethroids. The committee cooperated with university researchers to develop an extensive monitoring program in 1998 and 1999. The purpose of this paper is to report the results of the 1999 bollworm monitoring program.

Materials and Methods

Wire cone traps (Harstack et al. 1979) baited with artificial sex pheromone lures (Hendricks et al. 1987) were used to collect bollworm male moths from June through October. Moths were collected from cotton growing regions in Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Tennessee and Texas. Multiple collection locations were used in seven of the eleven participating states.

All of the vials used for testing were produced at a central location and then shipped to each participating state for testing. The interior of glass scintillation vials (20 ml) were coated with cypermethrin (5 µg/vial or 10 µg/vial). A discriminating dose has not been determined for the bollworm. However, Kanga et al. 1996, suggested 2.5 µg/vial as a possible discriminating dose for cypermethrin to bollworm. Without a definitive discriminating dose we chose to error on the high side when choosing doses to evaluate. The 5 µg/vial dose of cypermethrin was chosen as the low dose for this monitoring program because historical data exists for this dose against the bollworm (Bagwell et al. 1998). The 10 µg/vial dose of cypermethrin was chosen as

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the high dose because it is considered lethal to homozygous pyrethroid susceptible tobacco budworm, *Heliothis virescens*, moths as well as moths heterozygous for pyrethroid resistance (Plapp et al. 1987). Bollworm individuals surviving the 10 µg/vial dose also should be resistant to pyrethroids. Vials were stored in a dark area to prevent photodegradation of the pyrethroid insecticide. Acetone-treated vials were used to check for moth natural mortality.

Male moths were removed from the traps early in the morning to prevent desiccation. Only moths that appeared to be young and healthy were used in these tests. One moth was placed in each vial and held at room temperature for 24 hours. Mortality was determined by removing the moths from the vials and tossing them into the air. If the moth was unable to fly or could fly only a short distance (< 3 meters), it was recorded as dead. All data were corrected for control mortality using Abbott's (1925) formula.

Results and Discussion

From May to October 7,436 male bollworm moths were evaluated from eleven states for pyrethroid resistance using the adult vial test at a dose of 5 or 10 µg/vial of cypermethrin (Table 1). Survival at the 5 µg/vial dose of cypermethrin by state (Table 2and 2a) ranged from 0-18%, 0-34%, 0-17%, 0-14%, 0-6% and 0% in May, June, July, August, September and October, respectively. Alabama (July and August), Louisiana (May, June, July and August), Missouri (June), North Carolina (August) and South Carolina (June and July) were the collection locations that exceeded 10% survival at the 5 µg/vial dose. Survival at the 10 µg/vial dose of cypermethrin by state (Table 3 and 3a) ranged from 6%, 0-25%, 0-22%, 0-7%, 0-2% and 0-3% in May, June, July, August, September and October, respectively. Louisiana (July), Missouri (June) and South Carolina (June) were the only three collection locations to exceeded 15% survival at the 10 µg/vial dose.

Alabama

In July and August 361 male moths were evaluate from two counties. The highest level of survival at the 5 µg/vial dose was observed in August with 12% survival. At 10 µg/vial the highest survival was observed in August with 2%. Bollworm survival in Alabama in 1999 was essentially the same as that observed in 1998.

Arkansas

In July and August 116 male moths were evaluated from one county. The highest survival at the 5 µg/vial dose was observed in July with 2%. No survival was observed at the 10 µg/vial dose. Bollworm survival in Arkansas was generally lower in 1999 compared to that observed in 1998.

Florida

In July and August 133 male moths were evaluated from two counties. No survival was observed at the 5 or 10 µg/vial dose.

Georgia

In July and August 869 male moths were evaluated from three counties. 2% survival was observed at the 5 µg/vial dose in both July and August. No moths were tested at 10 µg/vial. Bollworm survival in Georgia in 1999 was essentially the same as that observed in 1998.

Louisiana

In May, June, July, August and September 1,116 male moths were evaluated from 20 parishes. The highest survival at the 5 µg/vial dose was in May with 18%. The highest levels of bollworm survival observed in 1999 were similar to that observed in 1998. However, high levels of bollworm survival at the 5 µg/vial dose was observed throughout the summer in 1999 but was not observed throughout the summer in 1998. At 10 µg/vial the highest survival was observed in July with 22%. The highest survival at 10 µg/vial in 1998 was 3.8%. So, a substantial increase in survival at the 10 µg/vial dose was observed in Louisiana in 1999.

Mississippi

In July and August 262 male moths were evaluated from one county. No survival was observed at the 5 or 10 µg/vial dose. Bollworm survival in Mississippi in 1999 was essentially the same as that observed in 1998.

Missouri

In June, July, August and September 334 male moths were evaluated from one county. The highest level of survival at the 5 µg/vial dose was observed in June with 34%. However, only seven moths were evaluated during June at 5 µg/vial. During the remainder of 1999, the highest level of survival observed at the 5 µg/vial dose was 6%. This was generally lower than in 1998. The highest level of survival at the 10 µg/vial dose was also observed in June with 16%. However, only seven moths were evaluated during June at 10 µg/vial. The next highest level of survival at 10 µg/vial was 7%. No survival was observed at 10 µg/vial in 1998.

North Carolina

In July, August and September 1,502 male moths were evaluated from six counties. The highest level of survival at the 5 µg/vial dose was observed in August with 13%. At the 10 µg/vial dose the highest survival was observed in August with 2%. Bollworm survival in North Carolina in 1999 was essentially the same as that observed in 1998.

South Carolina

In June, July, August, September and October 1,831 male moths were evaluated from 14 counties. The highest level of survival at the 5 µg/vial dose was observed in June with 25%.

At the 10 µg/vial dose the highest survival was also observed in June with 25%. However only eight moths were tested at each dose during June. In July with 277 moths tested 17% survival was observed at the 5 µg/vial dose and 6% survival was observed at the 10 µg/vial dose. This was a substantial increase in survival in 1999 compared to 1998.

Tennessee

In August 990 male moths were evaluated from five counties. Survival at the 5 µg/vial dose was 6%. At the 10 µg/vial dose 1% survival was observed.

Texas

In May, June, July, September and October 700 male moths were evaluated from one county. The highest level of survival at the 5 µg/vial dose was observed in September with 6%. At the 10 µg/vial dose the highest survival was observed in May with 6%. This was a slight increase in survival compared to 1998.

Conclusions

In 1998, five collection locations had survival to the 5 µg/vial dose greater than 10%, two locations had survival greater than 15% and one location had survival greater than 20%. In 1999, ten collection locations had survival to the 5 µg/vial dose greater than 10%, four locations had survival greater than 15% and two locations had survival greater than 20%. From 1988 to 1997 no bollworm collection in Louisiana had ever survived at levels greater than 15% at the 5 µg/vial dose (Bagwell et al. 1998). This increasing level of survival at the 5 µg/vial dose indicates that bollworm populations have an increasing level of tolerance to the pyrethroids.

Prior to 1998, no testing of bollworms has been reported at the 10 µg/vial dose of cypermethrin. In 1998 the highest level of survival at the 10 µg/vial dose was 4.9%. In 1999 six collections exceeded 5% survival, three collections exceeded 15% survival and two collections exceeded 20% survival.. Survival at this high dose would further indicate a change in the response of the bollworm to the pyrethroids. The indication of changing tolerance in the bollworm to the pyrethroid insecticides warrants further monitoring and investigations into the type and level of resistance present in these bollworm populations.

Resistance management plans have generally focused on maintaining the effectiveness of the pyrethroids against the tobacco budworm. However, reports of bollworm field control failures with the pyrethroid insecticides (Walker et al. 1997) and the increasing tolerance of the bollworm to the pyrethroids demonstrated in this study, suggest that maintaining the effectiveness of the pyrethroid insecticides against the bollworm should become a higher priority in future resistance management plans.

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Table 1. Responses of bollworm male moths to cypermethrin during 1998.

Location	Date	% Survival (No. Tested) 5 µg	% Survival (No. Tested) 10 µg
ALABAMA			
Macon (EVSRS)	June 25	0(3)	
Macon (EVSRS)	July 6	33(3)	0(5)
Macon (EVSRS)	July 12	0(6)	
Macon (EVSRS)	July 19	0(5)	
Macon (EVSRS)	July 27	33(4)	
Macon (EVSRS)	July 28	0(4)	
Macon (EVSRS)	July 29	0(2)	
Limestone (TVS)	July 31	20(6)	0(6)
Macon (EVSRS)	August 2	29(8)	
Limestone (TVS)	August 3	100(6)	0(6)
Macon (EVSRS)	August 4	27(17)	
Macon (EVSRS)	August 5	0(10)	
Limestone (TVS)	August 6	20(12)	0(12)
Macon (EVSRS)	August 6	9(11)	
Limestone (TVS)	August 7	0(4)	25(4)
Macon (EVSRS)	August 8	20(15)	
Limestone (TVS)	August 10	0(12)	0(13)
Macon (EVSRS)	August 11	14(27)	
Limestone (TVS)	August 11	0(6)	0(5)
Limestone (TVS)	August 12	0(6)	0(7)
Macon (EVSRS)	August 12	5(21)	
Limestone (TVS)	August 13	0(5)	0(5)
Macon (EVSRS)	August 13	10(11)	
Macon (EVSRS)	August 15	0(3)	
Limestone (TVS)	August 17	0(17)	7(16)
Limestone (TVS)	August 19	6(22)	0(22)
Limestone (TVS)	August 21	0(7)	0(7)
ARKANSAS			
Lonoke	July 14	13(8)	0(8)
Lonoke	July 19	0(5)	0(5)
Lonoke	July 20	0(10)	0(10)
Lonoke	July 21	0(5)	0(5)
Lonoke	July 26	0(5)	0(5)
Lonoke	July 27	0(5)	0(5)
Lonoke	July 28	0(5)	0(5)
Lonoke	July 29	0(5)	0(5)
Lonoke	August 4	0(5)	0(5)
Lonoke	August 5	0(5)	0(5)
FLORIDA			
Gadsden (NFREC)	July 15	0(20)	
Gadsden (NFREC)	July 26	0(10)	
Gadsden (NFREC)	July 28	0(4)	
Gadsden (NFREC)	August 12	0(15)	0(15)
Gadsden (NFREC)	August 12	0(14)	
Calhoun (Altha)	August 12	0(10)	0(10)
Gadsden (NFREC)	August 26	0(20)	
Gadsden (NFREC)	September 20	0(15)	
GEORGIA			
Brooks	July 1	0(30)	
Brooks	July 6	0(10)	
Tift	July 7	0(20)	
Burke	July 7	4(40)	
Brooks	July 7	2(50)	
Tift	July 8	0(20)	
Brooks	July 8	0(10)	
Tift	July 9	0(20)	
Tift	July 13	0(10)	
Burke	July 13	0(20)	
Tift	July 14	0(20)	
Tift	July 15	0(20)	
Tift	July 16	7(20)	
Burke	July 16	6(20)	
Tift	July 20	8(20)	
Tift	July 21	0(10)	
Tift	July 22	0(10)	
Brooks	July 26	0(10)	
Brooks	July 27	0(20)	
Brooks	July 28	0(28)	
Burke	July 29	0(20)	
Brooks	July 29	0(36)	
Brooks	July 30	7(10)	
Tift	August 3	0(10)	
Brooks	August 3	4(123)	
Tift	August 4	0(20)	
Burke	August 4	0(20)	
Brooks	August 4	2(50)	
Tift	August 5	0(20)	
Burke	August 5	0(20)	
Brooks	August 5	0(42)	
Tift	August 6	0(20)	
Brooks	August 6	0(50)	
Burke	August 30	6(20)	
LOUISIANA			
Bossier	May 20	38(10)	
Concordia	May 21	20(5)	
East Baton Rouge	May 21	0(5)	
Red River	May 26	0(10)	
Rapides	May 26	17(10)	
Grant	May 26	0(5)	
Rapides	May 26	0(5)	
St. Landry	May 26	33(5)	
Bossier	May 26	43(10)	
Caddo	May 26	25(10)	
Caddo	May 26	0(10)	
Morehouse	June 1	20(17)	
Bossier	June 2	0(10)	
Bossier	June 9	17(10)	
Bossier	June 16	29(10)	
Bossier (RRRS)	June 18	0(10)	0(10)
Bossier (RRRS)	June 23	0(10)	0(10)
Red River	June 23	0(8)	
Rapides	July 7	0(5)	
Rapides (Bunkie)	July 7	0(10)	0(10)
Franklin	July 7	0(5)	
Franklin	July 7	25(5)	
Caddo	July 7	20(5)	
Caldwell	July 7	0(5)	
Bossier	July 7	43(10)	
Rapides	July 7	20(10)	
Avoyelles	July 7	0(10)	
Red River	July 7	25(10)	

Rapides	July 7	30(10)	
Franklin (Gilbert)	July 12	36(25)	22(20)
Franklin (Gilbert)	July 12	0(25)	11(20)
Ouachita (Millhaven)	July 13	30(11)	
East Carroll	July 20	18(11)	
East Carroll	July 20	0(10)	
Ouachita	July 20	21(11)	
Madison	July 20	0(10)	
Morehouse	July 20	0(10)	
Richland	July 20	22(9)	
Morehouse	July 20	44(10)	11(10)
East Carroll (Gassoway)	July 20	22(9)	
Ouachita (North Monroe)	July 20	21(11)	
Richland (Start)	July 20	0(9)	
Morehouse (Bonita)	July 20	44(10)	11(10)
Red River (Coushatta)	July 21	0(10)	
Rapides	July 21	0(10)	
Avoyelles	July 21	0(10)	
Bossier	July 21	10(10)	
Red River	July 21	0(10)	
Red River	July 21	0(10)	
Caddo	July 21	0(5)	
Caddo	July 21	0(5)	
Tensas	July 22	0	56(40)
Ouachita	July 27	9(11)	
Richland	July 27	38(10)	13(10)
Tensas	July 27	13(8)	0(6)
Madison	July 29	0	0(10)
West Carroll	July 2	9(11)	0(10)
Richland	August 3	36(14)	
Morehouse	August 3	20(10)	
Madison	August 3	10(10)	
Madison	August 3	0(10)	
Tensas	August 3	17(14)	
East Carroll	August 3	11(20)	
East Carroll	August 3	15(20)	
Richland	August 3	20(10)	
Red River (Coushatta)	August 4	0(5)	0(5)
Caldwell	August 4	40(5)	
Caddo	August 4	33(5)	
Bossier	August 4	33(15)	
Natchitoches	August 4	50(10)	
DeSoto	August 4	40(5)	
Red River	August 4	11(10)	
Rapides	August 4	11(10)	
Avoyelles	August 4	0(10)	
East Carroll (Gassoway)	August 9	0(7)	
Morehouse (Mer Rouge)	August 9	0(9)	
Richland (Start)	August 9	0(10)	
Morehouse (Mer Rouge)	August 9	0(6)	
Ouachita	August 9	0(5)	
Morehouse	August 9	0(8)	
East Carroll	August 9	0(7)	
Morehouse	August 9	0(11)	
Richland	August 9	0(10)	
Morehouse	August 9	20(10)	
Morehouse	August 9	10(10)	
Madison	August 9	11(10)	
Morehouse	August 9	0(8)	
Bossier	August 18	11(10)	
Red River	August 18	0(10)	
Grant	August 18	0(7)	
St. Landry	August 18	0(7)	
Caddo	August 18	22(10)	
Morehouse	August 18	0(8)	
Morehouse	August 18	38(16)	
East Carroll	August 18	10(10)	
Madison	August 18	43(7)	
Red River (Coushatta)	August 18	0(10)	
Bossier (RRRS)	August 18	0(10)	
Rapides	September 2	0(10)	
Rapides (DLRS)	September 15	0(10)	

MISSISSIPPI

Leflore	July 15	0(14)	0(13)
Leflore	July 16	0(18)	0(17)
Leflore	July 23	0(24)	0(23)
Leflore	August 6	0(13)	0(13)
Leflore	August 12	0(15)	0(15)
Leflore	August 13	0(21)	0(20)
Leflore	August 27	0(28)	0(28)

MISSOURI

Pemiscot (Portageville)	June 29	34(7)	16(7)
Pemiscot (Portageville)	July 3	0(20)	0(20)
Pemiscot (Portageville)	July 7	0(15)	0(15)
Pemiscot (Portageville)	July 8	0(15)	0(15)
Pemiscot (Portageville)	July 9	0(13)	0(13)
Pemiscot (Portageville)	July 10	0(7)	0(7)
Pemiscot (Portageville)	August 10	21(20)	16(20)
Pemiscot (Portageville)	August 11	0(5)	0(5)
Pemiscot (Portageville)	August 17	0(10)	0(10)
Pemiscot (Portageville)	August 18	0(7)	16(7)
Pemiscot (Portageville)	August 24	0(7)	0(7)
Pemiscot (Portageville)	August 25	0(7)	0(7)
Pemiscot (Portageville)	August 26	0(15)	8(15)
Pemiscot (Portageville)	August 28	0(10)	0(10)
Pemiscot (Portageville)	September 9	0(9)	0(9)

NORTH CAROLINA

Washington	July 3	0(15)	0(15)
Washington	July 4	0(25)	0(25)
Washington	July 5	3(35)	0(35)
Washington	July 6	0(21)	0(21)
Washington	July 8	0(25)	0(25)
Washington	July 28	0(7)	0(7)
Washington	July 28	13(27)	0(27)
Washington	August 2	1(100)	0(100)
Washington	August 6	33(65)	5(65)
Onslow (Richlands)	August 9	0(5)	0(5)
Washington	August 10	10(70)	3(70)
Beaufort (Belhaven)	August 17	0(20)	0(20)
Washington	August 20	18(40)	3(40)
Gates	August 27	14(40)	5(40)
Halifax	September 9	5(50)	0(50)
Gates	September 9	10(100)	2(100)
Halifax	September 10	0(15)	0(15)
Upper Coastal Plain Res. Sta.	September 10	0(11)	0(11)
Halifax	September 14	0(26)	0(26)
Perquimans	September 20	6(16)	14(16)
Perquimans	September 21	3(38)	0(38)

SOUTH CAROLINA

Dillon (McSwain)	June 23	0(1)	0(1)
Sumter (Lowder)	June 23	0(2)	0(2)
Dillon (Gaddy)	June 23	100(2)	100(2)
Sumter (McDaniel)	June 23	0(1)	0(1)
Sumter (McDaniel)	June 23	0(1)	0(1)
Dillon (Dillon (Bryant))	June 23	0(1)	0(1)
Barnwell (EREC)	July 15	6(18)	6(18)
Bamberg (Brubaker)	July 15	0(4)	0(4)
Barnwell (EREC)	July 16	9(11)	9(11)
Calhoun (Capers Holman)	July 16	0(7)	0(7)
Barnwell (EREC)	July 18	0(9)	0(9)
Bamberg (Brubaker)	July 18	0(5)	0(5)
Bamberg	July 18	9(12)	0(12)
Barnwell (EREC)	July 20	0(10)	10(10)
Marlboro (McQuage)	July 20	0(2)	0(2)
Dillon (Gaddy)	July 20	0(1)	0(1)
Barnwell (EREC)	July 22	13(27)	8(27)
Bamberg (Bubba)	July 22	0(14)	0(14)
Darlington (PDREC)	July 22	0(1)	0(1)
Bamberg (Brubaker)	July 24	0(5)	0(5)
Bamberg	July 24	16(20)	0(20)
Barnwell (EREC)	July 25	22(10)	0(10)
Barnwell (EREC)	July 26	0(10)	0(10)
Bamberg	July 26	0(4)	0(4)
Sumter (McDaniel)	July 26	100(2)	0(2)
Darlington (Woodard)	July 26	100(6)	40(6)
Sumter (Lowder)	July 26	43(8)	72(8)
Sumter (Lowder)	July 26	67(3)	33(3)
Sumter (Rivers)	July 26	58(12)	0(12)
Sumter (Rivers)	July 26	50(10)	30(10)

Sumter (McDaniel)	July 26	33(8)	0(8)
Marlboro (Hinson)	July 26	0(3)	0(3)
Calhoun (Capers Holman)	July 27	11(10)	0(10)
Shicer	July 27	25(4)	25(4)
Barnwell (EREC)	July 29	0(4)	0(4)
Sumter (Rivers)	July 29	10(10)	0(10)
Sumter (McDaniel)	July 29	33(3)	0(3)
Darlington (Woodard)	July 29	30(10)	0(10)
Marlboro (Hinson)	July 29	10(10)	0(10)
Sumter (Lowder)	July 29	50(2)	0(2)
Sumter (McDaniel)	July 29	0(2)	0(2)
Barnwell (EREC)	August 3	0(20)	0(20)
Bamberg	August 3	8(13)	0(13)
Marlboro (McQuage)	August 3	0(4)	0(4)
Sumter (Rivers)	August 3	0(2)	0(2)
Dillon (Bryant)	August 3	0(3)	0(3)
Darlington (PDREC)	August 3	49(3)	0(3)
Marlboro (Hinson)	August 3	0(10)	0(10)
Marlboro (Rogers)	August 3	0(2)	-2
Dillon (Gaddy)	August 3	0(3)	0(3)
Darlington (Woodard)	August 3	0(4)	0(4)
Sumter (McDaniel)	August 3	0(10)	0(10)
Barnwell (EREC)	August 5	20(20)	0(20)
Bamberg (Brubaker)	August 5	0(15)	0(15)
Bamberg	August 5	23(13)	8(13)
Barnwell (EREC)	August 6	0(15)	0(14)
Bamberg (Brubaker)	August 8	0(15)	0(15)
Bamberg	August 8	0(15)	0(15)
Barnwell (EREC)	August 10	0(15)	0(15)
Calhoun (Capers Holman)	August	107(20)	0(20)
Barnwell (EREC)	August 12	0(5)	0(5)
Sumter (Rivers)	August 15	0(7)	0(7)
Sumter (Rivers)	August 15	0(10)	0(10)
Dillon (Gaddy)	August 15	0(9)	0(9)
Sumter (McDaniel)	August 15	0(10)	0(10)
Marlboro (McQuage)	August 15	0(8)	0(8)
Sumter (Lowder)	August 15	0(1)	0(1)
Sumter (McDaniel)	August 15	0(2)	0(2)
Darlington (Woodard)	August 15	0(2)	0(2)
Marlboro (Rogers)	August 15	0(1)	0(1)
Marlboro (Hinson)	August 15	0(8)	0(8)
Barnwell (EREC)	August 18	6(16)	0(16)
Bamberg	August 18	0(20)	0(20)
Barnwell (Sandifer)	August 18	0(20)	0(20)
Bamberg (Brubaker)	August 25	0(7)	0(7)
Bamberg	August 25	0(6)	0(6)
Bamberg	August 25	7(15)	0(15)
Barnwell (EREC)	August 31	0(22)	0(22)
Barnwell (EREC)	August 31	0(10)	0(10)
Bamberg	September 3	0(20)	0(20)
Barnwell (Sandifer)	September 3	17(8)	0(8)
Bamberg	September 5	5(20)	0(20)
Barnwell (Sandifer)	September 5	0(15)	0(15)
Barnwell (EREC)	September 7	0(12)	0(12)
Barnwell (EREC)	September 7	13(15)	0(15)
Barnwell (EREC)	September 12	8(30)	0(30)
Bamberg	September 12	11(10)	0(10)
Barnwell (EREC)	September 13	5(22)	0(22)
Bamberg	September 15	0(4)	0(4)
Barnwell (EREC)	September 16	0(20)	0(20)
Barnwell (EREC)	September 23	4(24)	0(24)
Barnwell (EREC)	September 28	0(19)	0(19)
Bamberg	September 28	0(3)	0(3)
Barnwell (Sandifer)	September 28	0(3)	0(3)
Barnwell (EREC)	October 8	0(15)	0(15)
Barnwell (EREC)	October 14	0(10)	0(10)
TENNESSEE			
Lake (Ridgely)	August 3	5(22)	0(2)
Gipson (Milan)	August 4	14(7)	
Lake (Ridgely)	August 5	4(28)	0(1)
Lake (Ridgely)	August 6	5(57)	10(10)
Haywood (Brownsville)	August 6	0(8)	
Fayette (Eads)	August 6	0(3)	
Gipson (Milan)	August 6	0(5)	0(3)
Lake (Ridgely)	August 9	4(24)	0(56)
Gipson (Milan)	August 9	0(7)	0(16)
Gipson (Milan)	August 11	0(12)	0(10)
Lake (Ridgely)	August 12	0(60)	0(20)
Lake (Ridgely)	August 13	3(30)	0(30)
Lake (Ridgely)	August 16	15(25)	0(15)
Madison (Jackson)	August 16	10(10)	0(3)
Gipson (Milan)	August 17	0(12)	0(10)
Fayette (Eads)	August 17	0(3)	0(4)
Lake (Ridgely)	August 18	0(42)	0(18)
Madison (Jackson)	August 18		0(7)
Lake (Ridgely)	August 20	14(51)	0(40)
Lake (Ridgely)	August 23	9(46)	1(92)
Lake (Ridgely)	August 27	9(50)	1(70)
Lake (Ridgely)	August 30	7(30)	2(51)
TEXAS			
Burleson	May 25	0(20)	6(20)
Burleson	June 8	2(50)	0(50)
Burleson	June 22	0(20)	5(20)
Burleson	June 29	11(30)	3(30)
Burleson	July 15	0(25)	0(25)
Burleson	July 19	0(20)	0(20)
Burleson	July 23	0(25)	4(25)
Burleson	July 26	0(25)	0(25)
Burleson	September 10	0(30)	0(30)
Burleson	September 16	8(30)	0(30)
Burleson	September 22	4(25)	0(25)
Burleson	September 28	17(20)	0(30)
Burleson	October 5	0(20)	3(30)

Table 2. Percent survival of bollworm male moths at 5µg cypermethrin per vial by state and month during 1999.

	%Survival (Number Tested)		
State	**May**	**June**	**July**
Alabama	---	0(3)	11(30)
Arkansas	---	---	2(48)
Florida	---	---	0(34)
Georgia	---	---	2(474)
Louisiana	18(85)	11(75)	14(366)
Mississippi	---	---	0(56)
Missouri	---	34(7)	0(70)
North Carolina	---	---	3(155)
South Carolina	---	25(8)	17(277)
Tennessee	---	---	---
Texas	0(20)	4(100)	0(95)

Table 2a. Percent survival of bollworm male moths at 5µg cypermethrin per vial by state and month during 1999.

	%Survival (Number Tested)		
State	**August**	**September**	**October**
Alabama	12(220)	---	---
Arkansas	0(10)	---	---
Florida	0(74)	---	---
Georgia	2(395)	---	---
Louisiana	14(399)	0(20)	---
Mississippi	0(77)	---	---
Missouri	6(81)	0(9)	---
North Carolina	13(340)	6(256)	---
South Carolina	4(381)	4(225)	0(25)
Tennessee	6(532)	---	---
Texas	6(105)	0(20)	---

Table 3. Percent survival of bollworm male moths at 10µg cypermethrin per vial by state and month during 1999.

State	%Survival (Number Tested)		
	May	June	July
Alabama	---	---	0(11)
Arkansas	---	---	0(48)
Florida	---	---	---
Georgia	---	---	---
Louisiana	---	0(20)	22(146)
Mississippi	---	---	0(53)
Missouri	---	16(7)	0(70)
North Carolina	---	---	0(155)
South Carolina	---	25(8)	6(277)
Tennessee	---	---	---
Texas	6(20)	2(100)	1(95)

Table 3a. Percent survival of bollworm male moths at 10 µg cypermethrin per vial by state and month during 1999.

State	%Survival (Number Tested)		
	August	September	October
Alabama	2(97)	---	---
Arkansas	0(10)	---	---
Florida	0(25)	---	---
Georgia	---	---	---
Louisiana	0(5)	---	---
Mississippi	0(76)	---	---
Missouri	7(81)	0(9)	---
North Carolina	3(340)	2(256)	---
South Carolina	0(380)	0(225)	0(25)
Tennessee	1(458)	---	---
Texas	---	0(115)	3(30)