UPDATE ON BOLLWORM PYRETHROID RESISTANCE MONITORING

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Abstract

Polyphagous bollworms are potentially exposed to pyrethroid insecticides during each generation. Since cotton is a host during the latter part of the growing season, any resistance developed during the season will reduce control realized in cotton. Pheromone traps have been used sporadically since the late 1980s throughout the cotton belt to collect male moths for testing resistance to a pyrethroid insecticide. Testing was conducted across the cotton belt in a coordinated fashion from 2007-2014 using a concentration of 5 µg/vial of cypermethrin as the diagnostic dose. Overall survival during 2014 was 18.8%, which was somewhat higher than recent years. However, resistance was not uniform across all states. Louisiana and Virginia have regularly had higher survival than all other states during recent years. This year Georgia joined them with all having yearly average survivorship between 30 and 35%. In contrast, Missouri, South Carolina and Tennessee all had average survival of less than 10%. The other states fell between these extremes.

Introduction

Bollworm, *Helicoverpa zea*, is a pest in numerous crops where it may be exposed to pyrethroid insecticides. Since it can have 5 or more generations per year in the southern U.S., it has the potential to develop large populations and insecticide resistance has the potential to develop and spread rapidly. One to two of these generations occur in cotton, causing substantial economic loss. Because pyrethroid insecticides are relatively inexpensive, they are often the first choice of growers for foliar control of bollworms. Knowledge of the susceptibility of bollworms to pyrethroid insecticides is therefore critical to effective management of this pest.

Monitoring pyrethroid resistance in bollworms has been conducted for numerous years, beginning in 1988 in a few states and then coordinated throughout the cotton belt in 1989-1990 (Rogers et al. 1990). Since then monitoring has continued at various levels every year. Regional data from previous years can be found in earlier Beltwide cotton

conference proceedings (Martin et al. 1999, 2000, Payne et al. 2001, 2002, Musser et al. 2010, 2011, 2013). During this time the bioassay methodology has remained consistent. Male moths are captured in a pheromone trap and placed in a glass vial that was previously treated with insecticide. Mortality is recorded after 24 h. A concentration of 5 µg cypermethrin / vial has been used with baseline survival generally less than 10% (Martin et al. 1999).

Materials and Methods

Hartstack pheromone traps were placed in various locations in ten states across the cotton belt from VA to TX. Pheromones (Luretape with Zealure, Hercon Environmental) were changed every 2 weeks. Some traps were monitored at least weekly from May until September, but most were monitored over a shorter period when bollworms were abundant and cotton was susceptible to bollworm feeding. Healthy moths caught in these traps were subsequently tested for pyrethroid resistance. Moths were individually placed in 20 ml scintillation vials that had been previously coated with 0 or 5 µg cypermethrin per vial. Vial preparation for all locations except Louisiana was done at Starkville, MS and shipped to cooperators as needed throughout the year. Louisiana data are from vials prepared in Louisiana. In addition to rates of 0 and 5 µg cypermethrin per vial, Louisiana also tested survival at 10 µg cypermethrin per vial. At all locations, moths were kept in the vials for 24 h and then checked for mortality. Moths were considered dead if they could no longer fly. Reported survival was corrected for control mortality (Abbott 1925).

Results and Discussion

A total of 8815 moths were assayed during 2014. The fewest moths (169) were tested in North Carolina while the most moths (2539) were tested in Louisiana. Average survival to the 5 µg cypermethrin / vial concentration was 18.8% in 2014 (Table 1), which was the highest rate of survival since 2007 (Fig. 1). As has been consistently observed in the past, survival during July was higher than during previous months. While late season moths are often more susceptible, survival rates during 2014 were maintained during August and September.

Table 1. Bollworm survival to 5 µg cypermethrin per vial in 24-h vial tests during 2014.

State	May	June	July	Aug	Sep	Overall	Total bollworms tested
AR	3.6	8.3	26.2	8.0	14.3	14.3	990
GA		8.3	20.8	42.1	21.6	30.4	787
LA	7.1	25.0	31.4	43.2	52.2	33.3	2539
MS	18.9	11.8	12.3	9.1		13.8	1178
MO				10.2	7.3	9.3	597
NC			24.4			24.4	169
SC		0.0	10.6	2.7	0.0	5.3	605
TN			7.6			7.6	261
TX		11.5	22.3	16.0	16.2	16.8	1220
VA			27.7	33.9	31.6	32.4	649
Average	9.9	10.8	20.4	20.7	20.5	18.8	8815

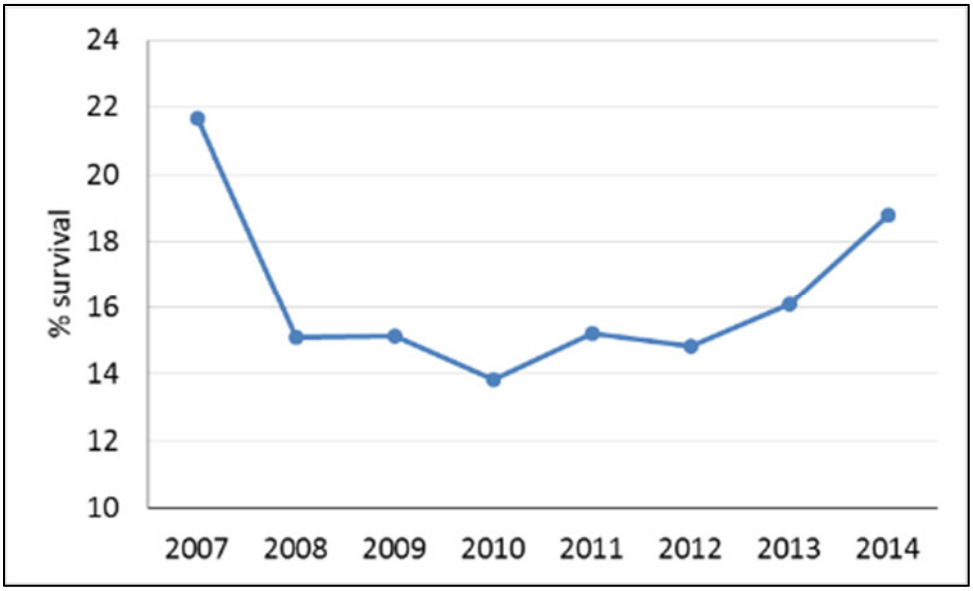

Fig. 1. Beltwide bollworm average survival per year at 5 µg cypermethrin per vial from 2007 – 2014.

Most states had survival rates similar to previous years, put survival in Georgia was sharply higher during 2014, making average survival in Georgia for the year similar to Louisiana and Virginia, the two states that have had the least susceptible moths during the last several years (Fig. 2). Whether this is a one-year spike like observed in 2007, or a long-term change in susceptibility remains to be seen. North Carolina has also had higher survival than most states each of the last two years, so it may be that pyrethroid resistance in bollworms is becoming more common along the eastern coast of the U.S.

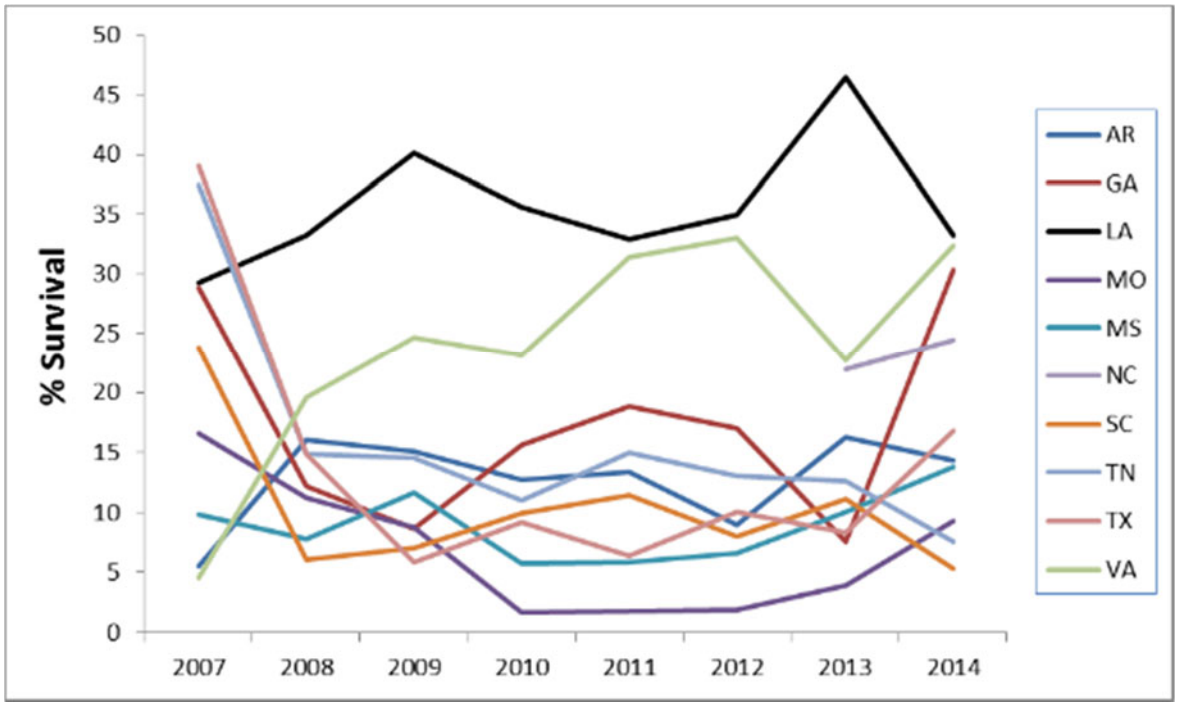

Fig. 2. Average bollworm survival by state per year at 5µg cypermethrin per vial from 2007 – 2014.

A comparison of bollworm susceptibility in Louisiana at both 5 µg and 10 µg cypermethrin, reveals that the relationship between these concentrations is not the same throughout the year. While survival during May and June was similar at both concentrations, survival continued to increase throughout the year at 5 µg, but stayed steady

between 20% and 30% survival at 10 µg (Fig. 3). For a point of reference, tobacco budworm was considered resistant to pyrethroids when there was 30% survival of the moths at the 10 µg concentration. Louisiana stayed near this line most of the year, and larval control of bollworms with pyrethroids is considered erratic.

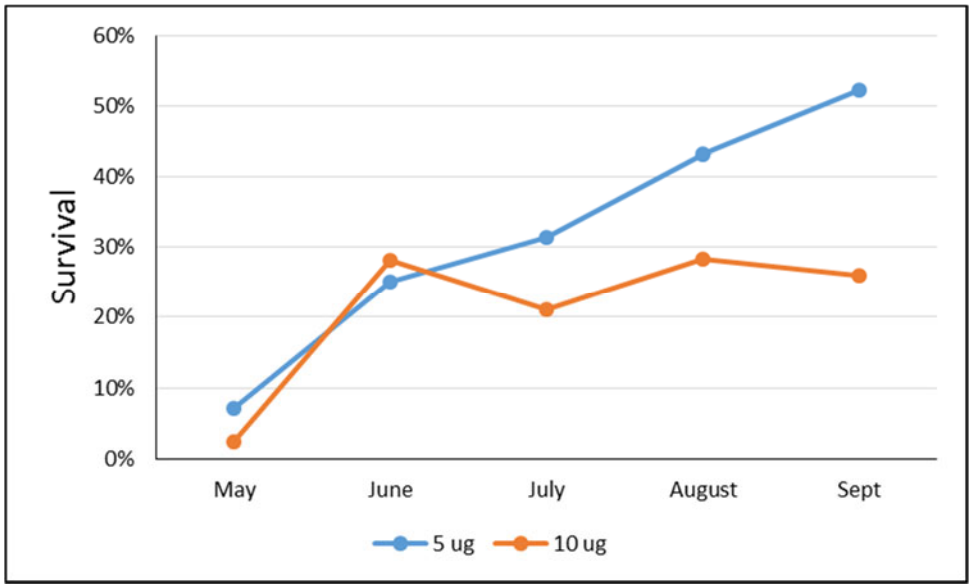

Fig. 3. Monthly bollworm survival at 5 µg and 10 µg cypermethrin per vial in Louisiana during 2014.

Bollworm adults are considered highly mobile (Lingren et al. 1994, Beerwinkle et al. 1995), which would suggest that pyrethroid resistance would quickly spread from one region to another. However, pyrethroid resistance has persisted in LA and VA for numerous years while populations in adjacent states remain largely susceptible. Field control of bollworm larvae is inconsistent throughout many parts of the cotton belt, so it is likely that numerous resistance genes are present in populations. It is likely that resistance is associated with high fitness costs, so resistance is reduced every winter, and spreads to new regions more slowly than expected. However, monitoring from 1998-2000 found average survival rates of less than 10%, while average current survival is approaching 20% and exceeds 30% in some states. Even though pyrethroids may not be applied as frequently in cotton as in the past, there are still enough applications made in the landscape to slowly decrease pyrethroid susceptibility, making the selection of this class of chemistry for targeting bollworms a risky decision.

Conclusions

Pyrethroid susceptibility in bollworms over the cotton belt appears to be slowly decreasing, but the rate of decline is not uniform. Louisiana and Virginia have had the lowest susceptibility for several years. Georgia has similar survival to pyrethroids during 2014. Average survival on 5 µg cypermethrin over the entire cotton belt rose to 18.8% during 2014, which was the highest survival observed since 2007.

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