BELTWIDE PYRETHROID RESISTANCE MONITORING OF BOLLWORMS

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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 2007-2012 using a concentration of 5 µg/vial of cypermethrin as the diagnostic dose. Overall survival during 2012 was 14.8%, which was similar to previous years. However, resistance was not uniform across all states. Louisiana and Virginia consistently had much higher survival than all other states with 35% and 33%, respectively. Survival was <20% in all other states. While there has been little change overall during the last six years of monitoring, a comparison of data from 1998-2000 with 2008-2010 data shows that overall survival at 5 µg/vial increased from 8% to 18% during the decade, and some increase was found in nearly all participating states. Consistent with historical data, survival was highest during July when moths emerge primarily from corn.

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. One to two of these generations occur in cotton, causing substantial economic loss. Because they are relatively inexpensive, pyrethroid insecticides 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. Throughout this time the 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 nine 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 April until October, but most were monitored over a shorter period when 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. 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). Vials were prepared in three laboratories and shipped to other locations as needed to verify results. Cross-checking between laboratories showed consistency in results.

Results and Discussion

Over all sites in the 9 participating states from 2007 through 2012, more than 10,000 moths were tested each year, with all states testing at least 500 moths per year. Average survival to the 5 µg cypermethrin / vial concentration was 14.8% in 2012, and was between 13.8% and 15.1% each year from 2008-2012. In 2007 the average survival was 21.7%. While the beltwide average has been consistent over the last 5 years, it has varied by state. Louisiana has consistently had the highest rates of survival, while Virginia resistance to pyrethroids has increased sharply since 2007 (Fig. 1). Several states had low susceptibility during 2007, but have returned to their more susceptible status since 2007. A more consistent trend emerges when viewed on a longer time scale. Monitoring data from 2008-2010 were compared to data from 10 years earlier as reported by Martin et al ((1999, 2000) and Payne et al. (2001). Over this decade, overall survival during July increased from 8.2% to 18.2%, and increased survival was recorded in almost every state (Musser et al. 2010). Not only was there variability by year, but also variability from month to month. Most states had the greatest survival to pyrethroids during July (Fig. 2). This is likely a result of moths being more fit during July because most of these moths are emerging from corn (unpublished data). Tennessee and Texas were the only states that did not peak in July. Data for both these states were strongly influenced by a single year with very high survival late in the year (Sept. 2007 in TN and Aug/Sept. 2008 in TX).

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, rather than observing a spread of resistance from a location, pyrethroid resistance has persisted in LA and VA for numerous years while populations in adjacent states remain susceptible. This suggests that either resistant bollworms are not as mobile as believed, or that the resistance being monitored is occurring locally, and does not reflect the broader bollworm populations in the region. Either way, the presence of persistent locations with lower susceptibility to pyrethroid insecticides indicates that pyrethroid resistance mechanisms exist in the bollworm populations, and that current pest management practices select for these resistance traits. Because survival in May tends to be low each year, there may be substantial fitness costs to the resistance, which has been sufficient to prevent (or at least minimize) the dispersal of resistant individuals into new regions.

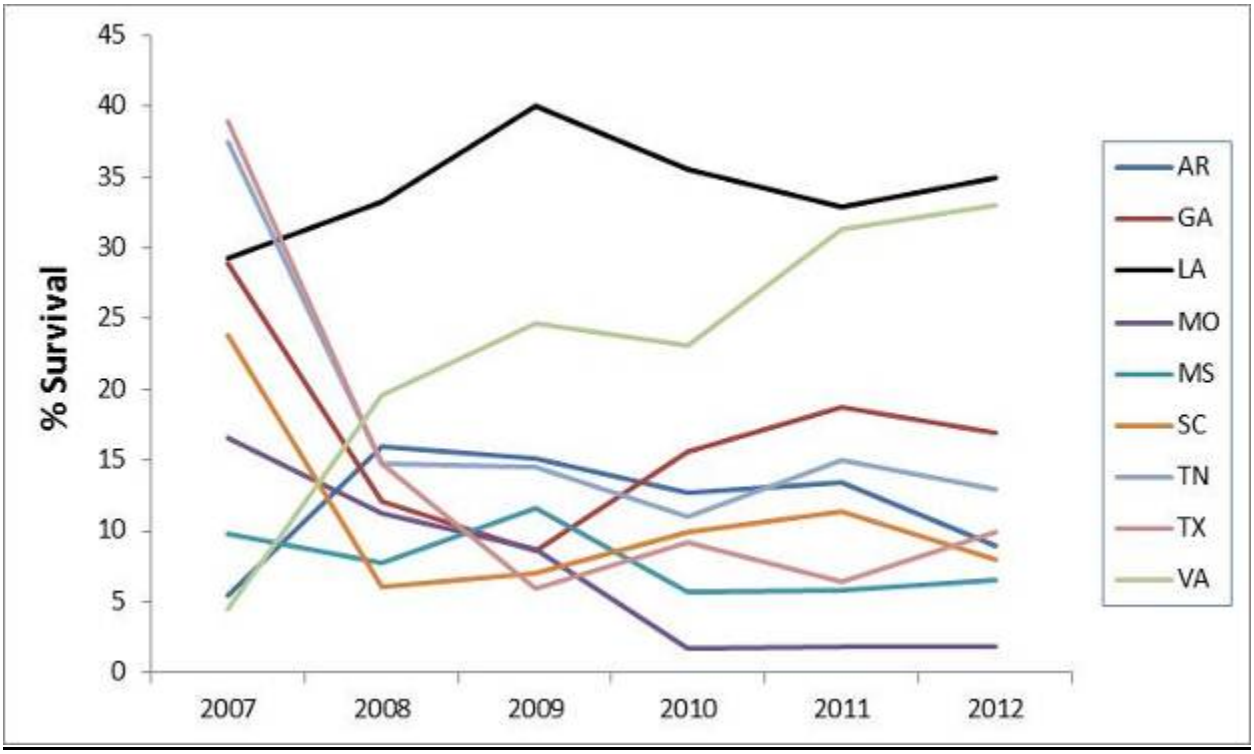

Figure 1. Average annual bollworm survival by state in an adult vial test using 5 µg cypermethrin/vial during 2007-2012.

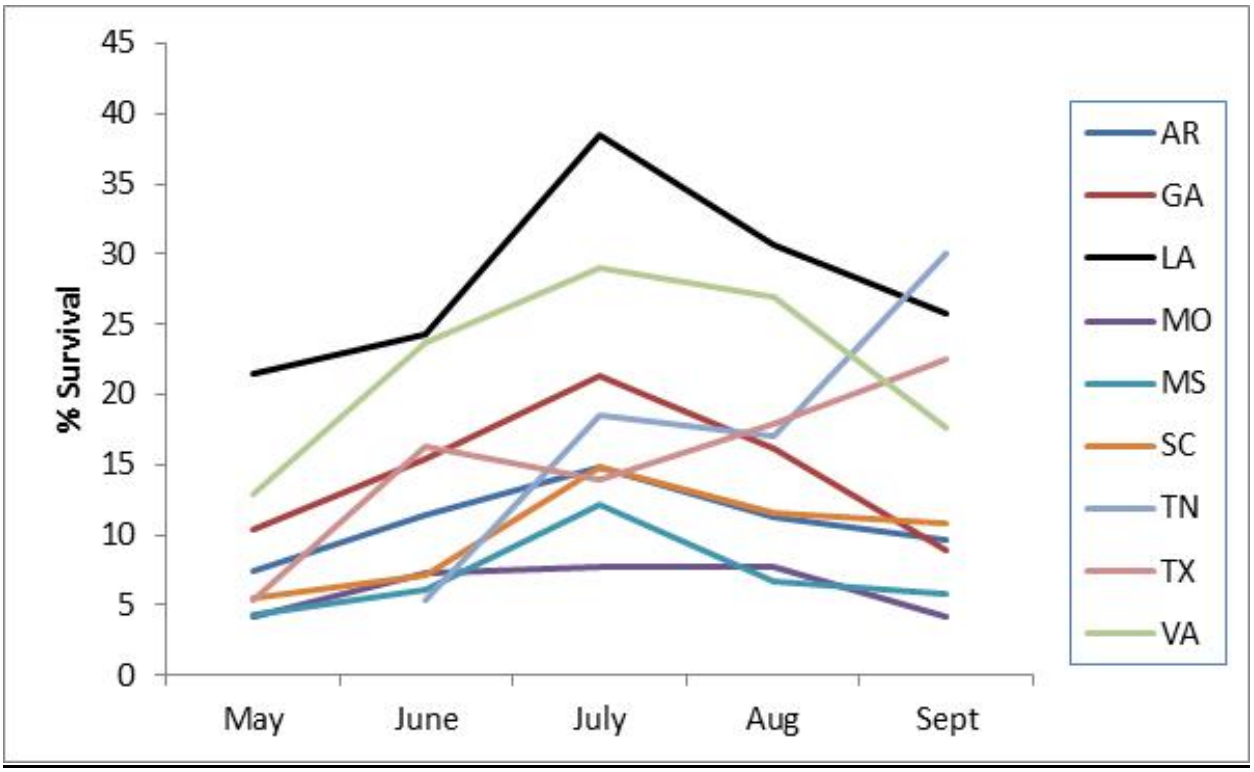

Figure 2. Average monthly bollworm survival in each state in the adult vial test using 5 µg cypermethrin/vial. Data averaged from 2007-2012.

Conclusions

Changes in bollworm resistance to pyrethroid insecticides could not be observed across the cotton belt during the last six years. However, there was a sharp increase in survival in Virginia, and Louisiana consistently had high survival levels. Survival rates were generally highest during July. Persistent differences in insecticide susceptibility among neighboring states suggest that either bollworms do not move as much as believed, or that the resistance is not stable due to one or more fitness costs.

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