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TEMPORAL AND SPATIAL VARIATION IN PHEROMONE TRAP CAPTURES OF HELICOVERPA ZEA AND HELIOTHIS VIRESCENS: WHAT DOES IT MEAN?

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Abstract

Male populations of the bollworm, *Helicoverpa zea*, and the tobacco budworm, *Heliothis virescens*, were monitored from 2003-2005 in Drew and Desha Counties, AR. During each year, 24-27 trap locations were established with at least one trap baited with *H. zea* female sex pheromone (zealure) and one trap baited with *H. virescens* (virelure) female sex pheromone. *H. zea* moths were collected in greater numbers in traps located next to corn (both non Bt and Bt corn) during the first weeks of June. Later in the year they are dispersed on a wider scale. During 2005, more *H. zea* moths were concentrated around traps located next to non Bt cotton during five weeks of July and August, which was a trend that was not observed in the previous two years. The only significant differences in captures of *H. virescens* was greater numbers of moths collected at interfaces of cotton (Bt and non Bt) and at Bt cotton-early soybean, but captures were extremely low during all three years of the study. A subset of trap captures during 2004 and 2005 was studied for relationships to cropping patterns within a half mile of each location, with no distinct pattern observed during both years.

Introduction

The bollworm, *Helicoverpa zea*, and the tobacco budworm, *Heliothis virescens*, have historically been two of the most destructive insect pests of cotton. *H. zea* is an economically important pest of at least four crops in southeastern Arkansas including corn, cotton, sorghum, and soybean. *H. virescens* is also polyphagous but is mainly a pest of cotton in southeastern Arkansas (Lincoln et al. 1967). A better understanding of the movement and distribution of these insects may help validate or repudiate ideas such as area-wide management (Knipling and Stadelbacher 1983) of these important agricultural pests.

Since the isolation and chemical syntheis of the female sex pheromone for *H. virescens* (Roelofs et al. 1974, Tumlinson et al. 1975, Klun et al. 1980), and *H. zea* (Klun et al. 1980), pheromone traps (Harstack et al. 1979) have been the main means of monitoring adults of these two insects. Field census of larval populations are relied upon for most control decisions, but pheromone traps produce additional information about the general population over some area larger than individual fields. Since the early 1980's the use of pheromone traps has provides a means to examine the temporal and spatial distribution of male moths in a given area. Because traps baited with female sex pheromone is only attractive to male moths, relationships between trap captures and numbers of female moths must be established to estimate the distribution of female moth populations. The relationship between pheromone trap captures of male moths and field populations of female moths (Witz et al. 1992, Latheef et al. 1993) and egg populations in cotton fields has previously been studied (Johnson 1983 and Leonard et al. 1989).

Materials and Methods

Male populations of *H. zea* and *H. virescens* were monitored from 2003-2005 in Drew and Desha Counties, AR. During each year, 24-27 trap locations were established with at least one trap baited with *H. zea* female sex pheromone (zealure) and one trap baited with *H. virescens* (virelure) female sex pheromone (during 2003, two traps were baited with zealure at each location in addition to one trap baited with virelure). At each trapping location, traps were placed at the interface of two agricultural crops with at least one of field of Bt cotton present at each location. The various interfaces included: 1) Bt cotton-Bt cotton, 2)Bt cotton-non Bt cotton, 3) Bt cotton-Bt corn, 4) Bt cotton-non Bt corn, 5) Bt cotton-grain sorghum, 6) Bt cotton-early maturing soybean variety, and 7) Bt cotton-late maturing soybean variety. During each year, a 3-4 replications were established for the various interface combinations except in 2005 where there was no Bt cotton-grain sorghum locations established. Traps were monitored from early June through August during each season. Weekly collections of male moths were converted to average daily capture for analysis. Analysis of variance was used to examine weekly moth captures at the various interface types for *H. zea* and *H. virescens*.

The percentage of the total land area devoted to the various type crops within a half mile radius of trap locations on R. A. Pickens and Son farm during 2004 (9 locations) and 2005 (8 locatioins) was studied and compared to the moth trap captures of both *H. virescens* and *H. zea* for June, July, and August of both years. Arc Gis software was used to digitize and develop farm maps. Planting and yield records were used to identify the various crop types and varieties grown on each field of the farm during both seasons. The software program was then used to establish a half-mile buffer around trap locations and this was used to estimate the various acreages of each field located within a particular trap buffer. The percentage of each crop type was calculated by adding the acres of like fields within a buffer and dividing by the total area within the buffer.

Results and discussion

Relatively low numbers of *H. virescens* were collected during the past three years in Drew and Desha counties. The greatest number of moths captured was during the week of June 23, 2003 when the average for all locations was 3.32 moths captured per night. The number of *H. virescens* moths caught at the various crop interfaces resulted in significant differences (P = 0.05) in only four weeks during the three year study. In 2003, for the week of July 30, the Bt cotton-late soybean interface and the Bt cotton-non Bt corn interface had significantly fewer moths collected than the Bt cotton-Bt cotton, Bt cotton-early soybean, and Bt cotton-non Bt cotton interfaces (P = 0.0387). A significantly greater number of *H. virescens* moths was collected from pheromone traps at the Bt cotton-non Bt cotton and Bt cotton-Bt cotton interfaces than at the Bt cotton-late soybean, Bt cotton-non Bt corn, and Bt cotton-Bt corn interfaces for the week of August 6, 2003 (P = 0.0387). During 2005, two weeks resulted in significant differences in the number of *H. virescens* moths captured at the various interfaces. For the week of May 27, more moths were collected at the Bt cotton-early soybean interface than at all other interfaces (P = 0.0339), and for the week of July 6, more were caught at the Bt cotton-early soybean interface than at the Bt cotton-non Bt corn, Bt cotton-Bt corn, and Bt cotton-late soybean interfaces (P = 0.0420). No significant differences were detected among interfaces for 2004 *H. virescens* collections.

During the first week of moth collections in 2003, June 4, more *H. zea* moths were captured in pheromone traps located at the Bt cotton-Bt corn interfaces (p= 0.0057) than all interfaces except the Bt cotton-non Bt corn. Significantly greater numbers *H. zea* moths were caught in pheromone traps located at the interfaces of Bt cotton-Bt corn and Bt cotton-non Bt corn than all other crop interfaces for the week of June 11 (P < 0.0001) and the week of June 18 (P = 0.0437), while the Bt cotton-Bt corn interface had significantly more moths than the Bt cotton-non Bt corn interface for the week of June 11. The Bt cotton-non Bt corn interface had significantly greater numbers of moth captured than all other crop interfaces for the week of June 25 (P < 0.0001).The only other significant difference found for *H. zea* moth captures during 2003 was for the week of August 20, when significantly greater numbers of moths were collected from the Bt cotton-late soybean interfaces as compared to the Btcotton-non Bt cotton, Bt cotton-non Bt corn, Bt cotton-sorghum, and Bt cotton-Bt cotton interfaces.

During 2004, significant differences were detected during three weeks of *H. zea* moth captures next to the various interface types. For the week of June 3, greater numbers of moths were collected at the Bt cotton-Bt corn and Bt cotton-non Bt corn interfaces than all other interface types except the ones by grain sorghum (P = 0.0171). Traps located at the Bt cotton-late soybean interfaces collected greater numbers of moths than all interfaces except the Bt cotton-grain sorghum and Bt cotton- non Bt cotton interfaces during the week of July 15 (P = 0.0473). Traps next to the Bt cotton-late soybean interfaces intercepted more moths than all interfaces except the Bt cotton-Bt cotton and the Bt cotton-conventional cotton interfaces for the week of August 21 (P = 0.0235).

During 2005, for the week of June 9, greater numbers of moths were collected by interfaces which included corn (both Bt and non-Bt) than at other interface types (P = 0.0001). Greater numbers of *H. zea* moths were collected at Bt cotton-Bt corn interfaces than at all others except Bt cotton-non Bt cotton and Bt cotton-non Bt corn during the week of June 16 (P = 0.0091). During the weeks of July 13 (P = 0.0044) and July 27 (P = 0.0141), the greatest number of moths were collected at the Bt cotton-non Bt cotton interfaces. During the weeks of July 20, August 3, and August 23, more *H. zea* moths were captured at the Bt cotton-non Bt cotton interfaces than all others except Bt cotton-Bt cotton and Bt cotton-early soybean on July 20 (P = 0.0309); all except Bt cotton-late soybean and Bt cotton-Bt cotton on August 3 (P = 0.0273); all except Bt cotton-Bt corn and Bt cotton-Bt cotton on August 23 (P = 0.0489).

The results of the pheromone trap captures generally show that *H. zea* moths were collected in greater numbers in traps located next to corn (both non Bt and Bt corn) during early June. Later in the year they seem to be dispersed on a wider scale. During 2005, more *H. zea* moths were concentrated around traps located next to non Bt cotton during five weeks of July and August, which was a trend that was not observed in the previous two years. The only significant differences in captures of *H. virescens* was greater numbers of moths collected at interfaces of cotton (Bt and non Bt) and at Bt cotton-early soybean, but captures were low during all three years of the study.

A subset of trap captures located on the R. A. Pickens and Son farm during 2004 and 2005 was studied for a relationship with the various crop types grown within a half mile of each location for the three months (June, July and August) of sampling during each year. The only significant correlations between *H. virescens* moths captures and the percentage of crop type within a half-mile radius was during the months of June and July during 2005 when significant negative correlations were observed for trap captures and the percentage of non Bt corn and total corn acreage (Table 1).

Table 1. Correlation matrix for *H. virescens* pheromone trap captures and the percentage of crop type grown within a half-mile radius of trap locations located on R. A. Pickens and Son Farm (* = P < 0.05; ** = p < 0.01).

	June		July		August	
	2004	**2005**	**2004**	**2005**	**2004**	**2005**
Bt corn	**0.38**	**0.45**	**-0.28**	**0.51**	**0.10**	**0.78***
Bt cotton	**-0.37**	**-0.25**	**-0.32**	**-0.22**	**-0.74***	**-0.21**
non Bt corn	**0.51**	**0.09**	**-0.28**	**-0.94****	**-0.21**	**-0.73**
non Bt cotton	**0.67**	**-0.31**	**-0.18**	**0.16**	**0.30**	**-0.21**
rice	**-0.44**	**-0.07**	**0.45**	**0.16**	**0.38**	**0.17**
soybean	**-0.69***	**0.12**	**0.55**	**0.49**	**0.30**	**0.62**
total cotton	**0.64**	**-0.46**	**-0.62**	**-0.05**	**-0.31**	**-0.34**
total corn	**0.67**	**0.17**	**-0.42**	**-0.91****	**-0.10**	**-0.64**
non-crop	**0.08**	**0.60**	**-0.25**	**-0.17**	**-0.52**	**-0.10**

Five significant correlations were detected between monthly *H. zea* pheromone trap captures and the crops located within a half mile radius of a trap location (Table 2). During 2004, significant negative relationship was detected between trap captures and soybean during June and Bt cotton during August. In 2005, a significant negative relationship was detected for non Bt corn and total acreage during July and a significant positive correlation was detected between Bt corn acreage and *H. zea* trap captures in August.

Table 2. Correlation matrix for *H. zea* pheromone trap captures and the percentage of crop type grown within a half-mile radius of trap locations located on R. A. Pickens and Son Farm (* = P < 0.05; ** = p < 0.01).

	June		July		August	
	2004	2005	2004	2005	2004	2005
Bt corn	**0.38**	**0.45**	**-0.28**	**0.51**	**0.10**	**0.78***
Bt cotton	**-0.37**	**-0.25**	**-0.32**	**-0.22**	**-0.74***	**-0.21**
conv corn	**0.51**	**0.09**	**-0.28**	**-0.94****	**-0.21**	**-0.73**
conv cotton	**0.67**	**-0.31**	**-0.18**	**0.16**	**0.30**	**-0.21**
rice	**-0.44**	**-0.07**	**0.45**	**0.16**	**0.38**	**0.17**
soybean	**-0.69***	**0.12**	**0.55**	**0.49**	**0.30**	**0.62**
total cotton	**0.64**	**-0.46**	**-0.62**	**-0.05**	**-0.31**	**-0.34**
total corn	**0.67**	**0.17**	**-0.42**	**-0.91****	**-0.10**	**-0.64**
non-crop	**0.08**	**0.60**	**-0.25**	**-0.17**	**-0.52**	**-0.10**

Only nine and eight trap locations in 2004 and 2005, respectively, were used in the correlation analysis of trap captures and the percentage of crop-types within a half-mile buffer of a location. As additional information is obtained for other trap locations in the study area, more significant correlations might result. A half-mile radius was chosen somewhat arbitrarily for this examination. It is the maximum distance for which we were able to obtain information as to what crop type was grown around most trap locations. Weather variable such as wind speed, wind direction, and temperature play a role in the actual direction and distance that a pheromone plume is dispersed in the environment. Therefore, the actual distance and direction of agricultural crops grown around a trapping location can vary in the influence they have in the production of male moths and the probability that they are intercepted by a trap. A better understanding of the environmental factors which cause differences in pheromone trap captures of moths in a given area may provide valuable information as to what drives populations for that area within a given season and across multiple years.

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