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INFLUENCE OF SURROUNDING CROP STRUCTURE ON HELIOTHINE TRAP CAPTURES IN ARKANSAS

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Abstract

A two year study was conducted in Southeast Arkansas to gain information about the spatial and temporal distribution of the cotton bollworm, *Helicoverpa zea*, in a heterogeneous cropping environment. In 2002, three pheromone traps baited with *H. zea* pheromone were placed in 24 locations throughout the area. In 2003, two pheromone traps baited with *H. zea* pheromone and one trap baited with tobacco budworm, *Heliothis virescens,* pheromone were placed in 26 locations across the landscape. Early in the season (June), greater numbers of *H. zea* moths were captured at the interfaces of conventional corn - Bt cotton in 2002, and conventional corn – Bt cotton and Bt corn – Bt cotton in 2003. Peak *H. zea* moths were collected in the last two weeks of July during both seasons. During 2003, the greatest number of *H. virescens* moths was caught during the fourth week of June at pheromone traps located at conventional cotton – Bt cotton interfaces. Surprisingly, captures of *H. virescens* moths did not increase from the early season catches. Correlation analyses with the number of *H. zea* moths caught and the percentage of the land associated with different crops or non-crop vegetation within 1, 2, 5, 10, and 20 mile distances of each pheromone trap location resulted in six significant ($p < 0.01$) correlations for cotton during the month of July during 2002, but results were not similar in 2003. Overall, correlations were highly variable during 2002 and 2003 with respect to the number of *H. zea* moths and the percentage of crop and non-crop land.

Introduction

The cotton bollworm, *Helicoverpa zea*, and the tobacco budworm, *Heliothis virescens*, collectively called heliothines, have historically been two of the most destructive pests of cotton. The polyphagous nature of *H. zea* causes it to be an economically important pest of at least four crops in Southeast Arkansas including corn, cotton, sorghum, and soybeans. *H. virescens* is also polypahgous but is mainly a pest of cotton in Southeastern Arkansas (Linconln et al. 1967). Both insects are highly mobile and are capable of moving into areas where suitable host plants are present. A better understanding of the movement and concentration of these insects may help validate or repudiate ideas such as area-wide management (Knipling and Stadelbacher 1983) of these agricultural pests. Also, if there is an influence in the number of insects infesting cotton due to the location of other host plants in the area, such as higher numbers of *H. zea* infesting cotton located near corn, then farmers may strategically plant conventional and Bt cotton fields based upon the probabilities of these possible influences.

Pheromone traps are commonly used to monitor populations of insect pests in many insect pest management programs. They are valuable tools for the estimation of the presence and number of adult insects present in a given area. In cotton pest management, traps baited with boll weevil pheromone are currently being used to help determine the timing and need of insecticide applications in eradication programs (Dickerson et al. 1987). For heliothines, efforts have been made to correlate trap captures to the number of eggs and moths in proximate cotton fields (Harstack and Witz 1981, Johnson 1983).

During 2002 and 2003, pheromone trap captures were examined to determine the temporal and spatial distribution of *H. zea* moths near six different crops in Southeast Arkansas. Traps were also used to monitor *H. virescens* during the 2003 growing season. A better understanding of the movement and concentration of these insect pests during the growing season may enable farmers to make decisions such as the judicious planting of Bt cotton in areas of the highest probable infestation.

Materials and Methods

During 2002, pheromone traps were placed at 24 locations in Drew, Desha, Lincoln, and Chicot counties in Southeast Arkansas. Traps were placed at the interfaces of Bt cotton and one of six different crop types. The six crop interfaces were Bt cotton-Bt cotton, Bt cotton-conventional cotton, Bt cotton-early soybeans, Bt cotton-late soybeans, Bt cotton-corn, and Bt cotton-grain sorghum. Three pheromone traps were placed at 4 replicates of each interface and were all baited with *H. zea* pheromone on a weekly basis. During 2003, pheromone traps were placed at 26 locations which included the interfaces used in 2002 and two additional locations of a Bt cotton-Bt corn interface. Again, three pheromone traps were placed at each in-

terface location, but one trap was baited with *H. virescens* pheromone and two traps with *H. zea* pheromone. Pheromone traps were baited and checked on a weekly basis from early June through the first week of September. The number of moths collected at each location on each week were counted and recorded. An analysis of variance was used to compare trap captures for the different crop interfaces for each week of moth collection.

During 2002 and 2003 satellite images of each trap location were produced to determine the types of crop and non-crop vegetation at varying distances from each pheromone trap. During 2002, the amount of acreage of the various agricultural crops within a 1, 2, 5, 10, and 20 mile radius from each trap location was provided by Southern Illinois University. A distance of 1, 2, 5, and 10 mile distance from each pheromone trap location was provided for the 2003 season. The percentage of land area in corn, cotton, soybeans, and non-crop land in these areas were compared to the number of *H. zea* moths caught at each location for each week to determine if crop acreage influenced moth captures.

Results and Discussion

The number of *H. zea* moths caught at the various crop interfaces resulted in significant differences ($p=.05$) during four weeks during 2002 (Figure 1) and five weeks during the 2003 (Figure 2) growing season. In both years, three weeks in June and one week in August resulted in significant differences. During 2002, pheromone traps located at the interface of Bt cotton-conventional corn caught significantly greater number of moths than all other crop interfaces for the week of June 10 ($p=0.0097$) and the week of June 17 ($p=0.0114$). For the week of June 2, the Bt cotton-conventional corn interface resulted in moth captures that were significantly greater than Bt cotton-cotton and Bt cotton-early soybeans interface ($p=0.0093$), but not greater than the Bt cotton-sorghum interface. During the week of August 12, pheromone traps located at the Bt cotton-Bt cotton interface caught significantly greater numbers of moths ($p=0.0287$) than all other interfaces except the Bt cotton- conventional corn interface.

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-conventional corn interface. Significantly greater numbers *H. zea* moths were caught in pheromone traps located at the interfaces of Bt cotton-Bt corn and Bt cotton-conventional 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 a significantly greater number of moths than the Bt cotton-conventional corn interface for the week of June 11. The Bt cotton-conventional corn interface had significantly greater numbers of moth captures 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 than the Bt cotton-conventional cotton, Bt cotton-conventional corn, Bt cotton-sorghum, and Bt cotton-Bt cotton interfaces ($p=0.0358$).

Only two weeks had significant differences in the number of *H. virescens* moths (Figure 3) caught at the various crop interfaces during 2003. For the week of July 30, the Bt cotton-late soybean interface and the Bt cotton-corn interface had significantly fewer number of moths collected than the Bt cotton-Bt cotton, Bt cotton-early soybeans, and Bt cotton-conventional cotton interfaces ($p=0.0378$). A significantly greater number of *H. virescens* moths were collected from pheromone traps at the Bt cotton-conventional cotton, and Bt cotton-Bt cotton interfaces than at the Bt cotton-late soybeans, Bt cotton-conventional corn, and Bt cotton-Bt corn interfaces for the week of August 6 ($p=0.0387$).

The results of the pheromone trap captures show that *H. zea* moths were collected in greater numbers in traps located next to conventional corn in 2002 and conventional and Bt corn in 2003 (Bt corn was only used in 2003) during the first weeks of each season. Only one week after June had significant differences in the number of *H. zea* moth captures at the different crop interfaces during both seasons. These pheromone trap data suggest that male *H. zea* is concentrated around corn early in the season, and are widely dispersed later in the year after corn is no longer a suitable host.

Correlation analysis was used to examine the number of *H. zea* moths captured each week relative to the percentage of the various agricultural crops grown within a 1, 2, 5, 10, and 20 mile radius of each pheromone trap location in 2002. During 2003, the number of *H. zea* moths captured in pheromone traps was related to the percentage of crop land grown within a 1, 2, 5, or 10 mile radius from each crop. The total number of significant correlations ($p<0.01$) between number of *H. zea* moths captured at the various trap locations in 2002 and the percentage of crop type within the five distances are provided in Table 1 for 2002 and Table 2 for 2003. For the month of July 2002, 7 (6 positive and 1 negative) significant correlations between *H. zea* moths and the percentage of cotton grown within 1, 2, 5, 10, or 20 mile distance were found, while only one positive correlation was observed in 2003. Three positive significant correlations were found in the number of *H. zea* moths captured and the percentage of soybeans within the various areas during the month of June 2002, while 9 significant positive correlations were detected for this month in 2003. Two significant positive correlations were found between corn and trap captures for the month of July and August/September during 2002, while 10 significant positive correlations were found for the month of June during 2003. The percentage of land not devoted to agricultural crops was negatively correlated with trap captures during July 2002, and 7 significant negative correlations were observed in June 2003.

The relationship between *H. zea* pheromone trap captures and the percentage of agricultural crops grown within the Northeast, Northwest, Southeast, and Southwest quadrants of each distance were also measured with correlation analysis. During both years, 14 weeks of pheromone trap captures were used for the correlations with the quadrants within 1,2,5,10 and 20 mile distances during 2002 (Table 3) and 1,2,5, and 10 mile distances during 2003 (Table 4). The percentage of cotton grown to the Southwest of each pheromone trap location resulted in 7 significant ($p < 0.01$) positive correlations during 2002, but none during 2003. The percentage of corn grown to the Southeast of the pheromone trap locations resulted in 8 significant positive correlations during 2002 but only one during 2003. For 2002, positive significant correlations were found in the percentage of land devoted to soybeans to the Northeast, Northwest, and Southeast of the pheromone trap locations and the number of *H. zea* moths captured. During 2003, significant positive correlations were observed for soybeans grown in the Northeast, Northwest, and Southwest quadrant. All other significant correlations ($p < 0.01$) are provided in Tables 3 and 4.

The exploratory nature of the correlation analyses was used as a first step to uncover possible trends in the relationship of crop type and the movement of *H. zea* at various times during the growing season. The heterogeneous landscape in Southeast Arkansas provides this insect pest with numerous hosts to feed upon and develop. A better understanding of the relationship between the number of moths moving into a location and the amount of the various host plants (crops) may provide information as to the probability of damaging populations in a given area during the season. The current study suggests that surrounding crop hosts may have an influence on trap captures of H. zea, but the effect is variable and may be associated with other sources of variability not partitioned in this study.

References

Dickerson, W. A., R. L. Ridgway, F. R. Planer. 1987. Southeastern boll weevil eradication program: improved pheromone traps and program status. Pp 335-337 *In* Proc. Beltwide Cotton Prod. Res. Conf. National Cotton Council, Memphis, TN.

Harstack, A. W., and J. A. Witz. 1981. Estimating field populations of tobacco budworm moths from pheromone trap catches. Environ. Ent. 10: 908-914.

Johnson, D. R. 1983. Relationship between tobacco budworm (Lepidoptera: Noctuidae) catches when using pheromone traps and egg counts in cotton. J. Econ. Entomol. 76: 182-183.

Knipling, E. F., and E. A. Stadelbacher. 1983. The rationale for areawide management of Heliothis (Lepidoptera: Noctuidae) populations. Bull. Entomol. Soc. Am. 29: 29-37.

Lincoln, C., J. R. Phillips, W. H. Whitcomb, G. C. Dowell, and W. P. Boyer. The bollworm-tobacco budworm problem in Arkansas and Louisiana. Arkansas Agric. Exp. Stn. Bull. Vol. 720. 66 pp.

Table 1. Total number of significant correlations ($p<0.01$) (positive (+) and negative (-)) between the number of *H. zea* moths captured in pheromone traps during the 14 weeks of collection in 2002 and the % of the crop type within a 1, 2, 5, 10, and 20 mile radius from each trap location.

	2002 *H. zea* pheromone trap captures					
	June (4 weeks)		**July (5weeks)**		**Aug/Sep (5 weeks)**	
Crop Type	**+**	**_**	**+**	**_**	**+**	**_**
Cotton	0	0	6	1	0	0
Soybeans	3	0	0	0	0	2
Corn	0	0	2	0	2	0
Non-crop	0	0	0	4	0	0

Table 2. Total number of significant correlations (p<0.01) (positive (+) and negative (-)) between the number of *H. zea* moths captured in pheromone traps during the 14 weeks of collection in 2003 and the % of the crop type within a 1, 2, 5, and 10 mile radius from each trap loc.

	2003 *H. zea* pheromone trap captures					
	June (4 weeks)		**July (5 weeks)**		**Aug/Sep (5 weeks)**	
Crop Type	**+**	**_**	**+**	**_**	**+**	**_**
Cotton	0	0	1	1	3	0
Soybeans	9	0	0	1	1	1
Corn	10	0	1	1	0	2
Non-crop	0	7	0	0	0	0

Table 3. Total number of significant correlations (p<0.01) (positive (+) and negative (-)) between the number of *H. zea* moths captured in pheromone traps during the 14 weeks of collections in 2002 and the % of the crop type within the NE, NW, SE, and SW quadrants of a 1, 2, 5, 10, and 20 mile radius from each trap location.

	2002 *H. zea* pheromone trap captures							
	NE Quadrant		**NW Quadrant**		**SE Quadrant**		**SW Quadrant**	
Crop Type	**+**	**_**	**+**	**_**	**+**	**_**	**+**	**_**
Cotton	2	0	2	1	2	1	7	3
Soybeans	3	0	4	3	2	0	0	0
Corn	0	0	2	2	8	1	2	0
Non-crop	0	1	5	0	0	1	5	4

Table 4. Total number of significant correlations (p<.01) (positive (+) and negative (-)) between the number of *H. zea* moths captured in pheromone traps during the 14 weeks of collections in 2003 and the % of the crop type within the NE, NW, SE, and SW quadrants of a 1, 2, 5, and 10 mile radius from each trap location.

	2003 *H. zea* pheromone trap captures							
	NE Quadrant		**NW Quadrant**		**SE Quadrant**		**SW Quadrant**	
Crop Type	**+**	**_**	**+**	**_**	**+**	**_**	**+**	**_**
Cotton	2	0	0	3	0	2	0	0
Soybeans	4	0	2	0	0	0	1	3
Corn	1	0	2	1	1	1	1	3
Non-crop	0	0	0	0	0	0	2	0

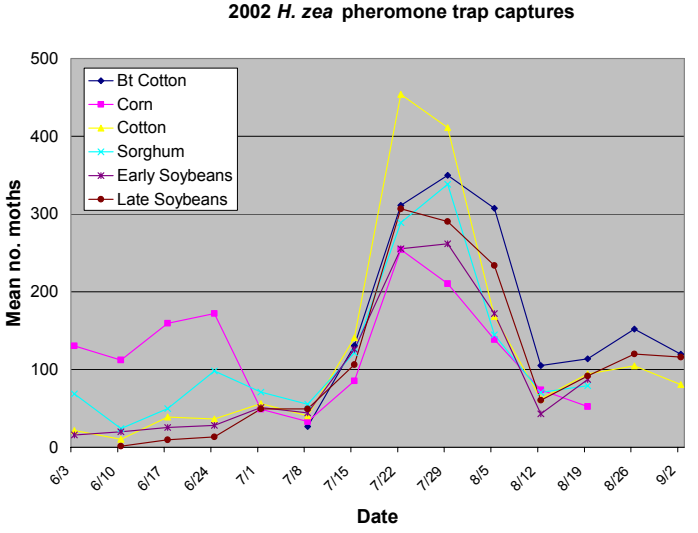

Figure 1. Mean number of weekly *Heliocoverpa zea* moth captures per trap at the various Bt cotton – alternate host interfaces during the 2002 season.

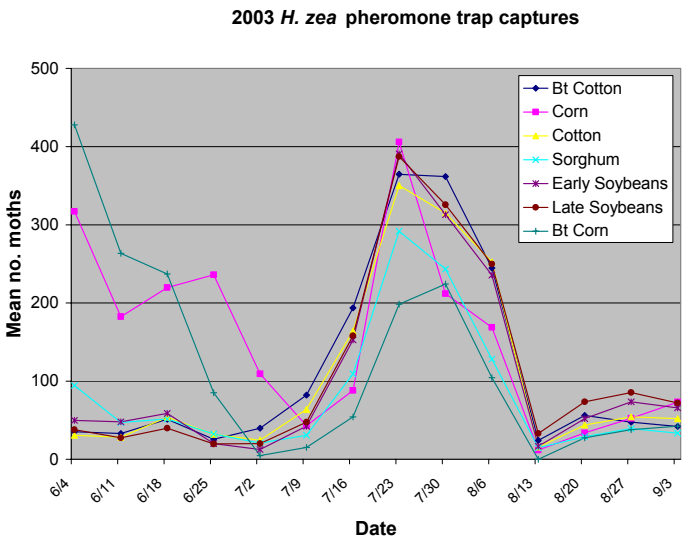

Figure 2. Mean number of weekly *Heliocoverpa zea* moth captures per trap at the various Bt cotton – alternate host interfaces during the 2003 season.

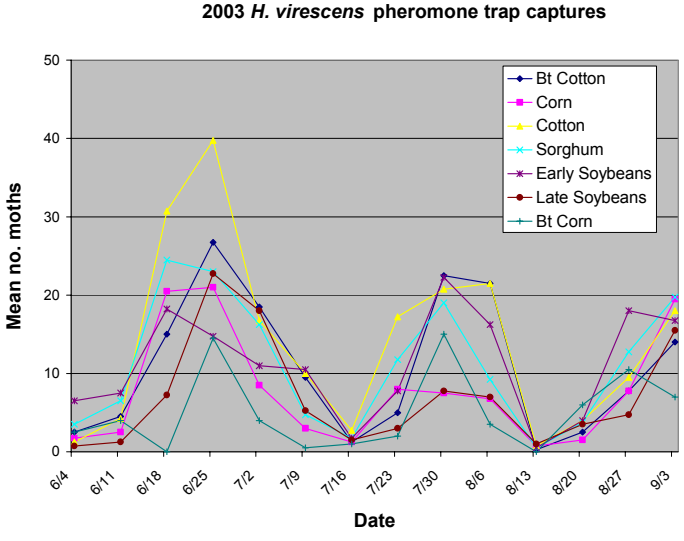

Figure 3. Mean number of weekly *Heliothis virescens* moth captures at the various Bt cotton – alternate host interfaces during 2002 season.