SEASONAL DISTRIBUTION OF BOLL WEEVILS, *ANTHONOMUS GRANDIS*, CAPTURED IN PHEROMONE TRAPS NEAR COTTON AND UNCULTIVATED HABITATS IN CENTRAL TEXAS

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Abstract

Boll weevil eradication programs in the U.S. rely heavily on trap captures of boll weevils to determine the need for insecticide applications. However, currently available information regarding the interpretation of trap captures and parameters influencing the optimal design of trapping systems is incomplete. A field study was initiated in the Brazos Valley of Texas during the spring of 2000 to examine several dynamic facets of boll weevil trap captures. An objective of this study addressed herein was to examine the influence of trap distance from cotton on the seasonal distribution of boll weevil captures. Overall, weevil captures by traps > 1000 m from cotton were less than by traps closer to cotton. Trap captures were highest during the cotton harvest period at all trap distances, but seasonal patterns corresponding to other agronomic periods varied among trap distance classes. Seasonal patterns in captures also differed between years of the study, primarily because of depressed trap captures during the harvest period of 2001, which likely resulted from ULV malathion applications by the Texas Boll Weevil Eradication Foundation during the first-year diapause phase in this region. Of particular interest, the characteristic depression of trap captures associated with the squaring and early-bloom period in cotton was less evident for traps located between 100 and 1000 m from cotton than for traps located within 100 m of cotton. These results provide additional insight into the spatial dynamics of boll weevil trapping that may result in improved monitoring systems for eradication efforts.

Introduction

The boll weevil, *Anthonomus grandis* Boheman, remains a serious economic pest in areas of the U.S. Cotton Belt and other parts of the world. Although eradication efforts have successfully reduced the geographic range of this pest, a critical need exists to improve efficiency of these efforts, and to maximize the effectiveness of monitoring programs to detect populations re-infesting eradicated areas. Eradication programs rely almost exclusively on pheromone traps for weevil detection and population monitoring. However, additional information regarding the interpretation of trap captures and factors influencing the optimal design of trapping systems is needed.

The seasonality of boll weevil trap captures has been well documented, both in reference to time-of-year (Guerra and Garcia 1982, Lopez 1980, Merkl and McCoy 1978), and with respect to the phenology of the cotton crop (Ridgway et al. 1976, Rummel and Bottrell 1976). However, authors have not always agreed as to the factors responsible for the seasonal patterns of capture. Regardless, it is widely recognized that captures are greatly depressed when traps are placed in close proximity to squaring cotton. More recent research has indicated that seasonal patterns of trap captures are influenced by the distance between traps and the standing cotton crop (Coppedge et al. 1996, Beerwinkle et al. 1996), and the possibility exists that trap captures at some distance from cotton may provide useful population information during the period when cotton is actively fruiting.

In the spring of 2000, we initiated a large-scale trapping study in the Brazos Valley of Texas to examine several aspects of the dynamics of boll weevil trap captures. One objective of this study, reported here, was to examine the influence of trap distance from cotton on the seasonal distribution of trap captures, in particular reference to defined periods during the cropping year.

Materials and Methods

Seventy-one pheromone traps (Hercon Environmental, Emigsville, PA) were deployed in a 256-km^2 (100-mi^2) transect of the Brazos Valley near Mumford, TX. Cotton was the primary crop grown in this region between the Brazos River to the west and the Little Brazos River to the east. Traps were inspected twice weekly (Tuesday and Wednesday) from Feb. 15, 2000 to Nov. 7, 2001, and 10-mg pheromone lures (Hercon Environmental, Emigsville, PA) were replaced in each trap every two weeks. Weekly total captures were calculated for each trap that was functioning on both sampling days.

Field Mapping

Trap locations and agricultural field boundaries were determined using GPS (Figure 1). Garmin GPS III and GPS III Plus receivers were used along with Garmin GBR21 beacon receivers (Garmin Corp., Olathe, KS) for differential measurements.

The receiver was set to average 20 observations to obtain the trap coordinates (latitude, longitude) with a 2- to 3-meter position accuracy. For areas not accessible by vehicle, satellite images were used to mark pastures and other uncultivated areas.

Agronomic Stages

Phenological development of cotton was determined by in-field observation throughout the growing season. Planting dates and harvest dates (for 18 fields in 2000 and 24 fields in 2001) were obtained from producers or by observation while sampling the traps. Dates of other agronomic stages were based on the first known occurrence of each stage from field observations. Classes were defined for five agronomic stages: planting, seedling, squares to first bloom, blooming to defoliation, and harvest. The planting stage covered the period from planting to emergence. The seedling stage extended from plant emergence until pinhead squares developed. The square to first bloom stage extended from pinhead squares until first bloom. The blooming to defoliation stage extended from blooming until defoliants were applied. The harvest stage covered the period from defoliation to harvest.

Distance Calculations

Distances from traps to the nearest cotton field were calculated for each trap using analysis modules of a geographic information system (IDRISI version 2, Clark Labs, Worcester, MA). Distances from traps to the nearest cotton field were categorized as <100 m, 100 to 1000 m, or >1000 m.

Statistical Analysis

Traps with missing data during an agronomic stage in a given year were excluded from analysis for that data group. Mean weekly captures were calculated for traps that had no missing data for a given agronomic stage. Capture data were subjected to analysis of variance using the SAS procedure PROC GLM (SAS Institute 2000). Means corresponding to main effects were agronomic stage, year, and distance to cotton, and terms for their interactions were included in the model. Main effects were separated using the REGWQ option of PROC GLM (SAS Institute 2000). Significant interactions were evaluated using the PDIFF and ADJUST=TUKEY options of the LSMEANS statement of PROC GLM (SAS Institute 2000).

Results and Discussion

Trap captures varied among agronomic stages (F = 73.15; df = 4, 605; $P < 0.01$). Mean capture was highest at harvest (69.7 weevils trap^{-1} week^{-1}) followed by the seedling (27.1 weevils trap^{-1} week^{-1}), planting (12.6 weevils trap^{-1} week^{-1}), squares to first bloom (16.1 weevils trap^{-1} week^{-1}), and blooming to defoliation (7.7 weevils trap^{-1} week^{-1}) stages. Captures at planting, squares to first bloom, and blooming to defoliation stages were not different. Captures were higher in 2000 (35.5 weevils trap^{-1} week^{-1}) than in 2001 (19.0 weevils trap^{-1} week^{-1}) (F = 34.86; df = 1, 605; $P < 0.01$). However, captures between years were significantly different only during the harvest stage. The agronomic stage by year interaction indicated that the influence of agronomic stage on trap capture differed between years (F = 41.22; df = 4, 605; $P < 0.01$) (Table 1). The significant agronomic stage by year interaction was largely caused by differences between years during the harvest period; captures at harvest were significantly higher than at other agronomic stages in 2000, but captures at harvest were not significantly different than captures at other agronomic stages in 2001. The significantly decreased trap capture at harvest in 2001 may have resulted from weekly treatments of ULV malathion by the Texas Boll Weevil Eradication Foundation during the first-year diapause phase in the Southern Blacklands zone.

Trap captures varied among distances to cotton (F = 20.20; df = 2, 605; $P < 0.01$). Significantly fewer boll weevils were captured in traps located more than 1000 m from cotton (16.3 weevils trap^{-1} week^{-1}) than in traps located less than 100 m from cotton (31.6 weevils trap^{-1} week^{-1}) and in traps located 100 to 1000 m from cotton (35.2 weevils trap^{-1} week^{-1}) (Table 2). The distance by year interaction was not significant which indicated that distance patterns in capture were consistent between years. The distance by stage interaction was significant (F = 9.82, df = 8, 605, $P < 0.01$), but captures were significantly different only during the harvest stage. Interestingly, during a period when captures by traps adjacent to cotton fields are normally depressed (squares to first bloom), corresponding captures by traps between 100 and 1000 m from cotton were numerically higher than those of traps within 100 m of cotton although this difference was not statistically significant ($P = 0.08$).

Conclusions

This preliminary spatial analysis has revealed that much of the variation of trap captures of boll weevils is attributed to year, agronomic stage, and distance to cotton. Seasonal patterns of boll weevil trap captures near cotton were consistent with previously published reports. However, first-year diapause spray treatments by the Boll Weevil Eradication Program appeared to significantly suppress weevil populations at the harvest stage. The results suggest that traps located some distance from cotton may prove more effective than traps near cotton for detecting weevil populations during the period of depressed captures (i.e., squaring to first bloom stage). A more stringent analysis of the data after the conclusion of the experiment may provide more insight into this interaction. It is possible that these findings will result in adjustments to current trapping systems, involving traps placed at specific distances from cotton, that will provide useful trapping data during periods when traps adjacent to fields provide minimal information.

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Disclaimer

Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U. S. Department of Agriculture.

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Table 1. Mean weekly capture of boll weevils in pheromone traps relative to year and at different agronomic stages of cotton development, Mumford, TX, 2000 - 2001.

	2000		2001	
Agronomic Stage	**n**	**Mean**	**n**	**Mean**
Planting	51	4.45 d	63	20.57 ab
Seedling	62	27.26 b	68	29.63 a
Squares to Early-Bloom	64	24.75 bc	66	11.18 bc
Late-Bloom to Defoliation	63	9.45 cd	67	6.16 c
Harvest	70	101.65 a	61	28.42 ab

Within a column, means followed by the same letter are not significantly different at $\alpha = 0.05$.

Table 2. Mean weekly capture of boll weevils in pheromone traps relative to distance from cotton and at different agronomic stages of cotton development, Mumford, TX, 2000 - 2001.

Agronomic Stage	**Distance ≤ 100 m**		**100 m < Distance ≤ 1000 m**		**Distance > 1000 m**	
	n	**Mean**	**n**	**Mean**	**n**	**Mean**
Planting	41	14.80 b	29	17.86 bc	44	4.88 b
Seedling	46	27.79 b	37	39.78 b	47	17.77 ab
Squares to Early-Bloom	52	8.34 b	31	30.46 bc	47	15.09 ab
Late-Bloom to Defoliation	52	10.72 b	32	7.62 c	46	5.07 b
Harvest	52	95.03 a	36	64.00 a	43	36.08 a

Within a column, means followed by the same letter are not significantly different at $\alpha = 0.05$.

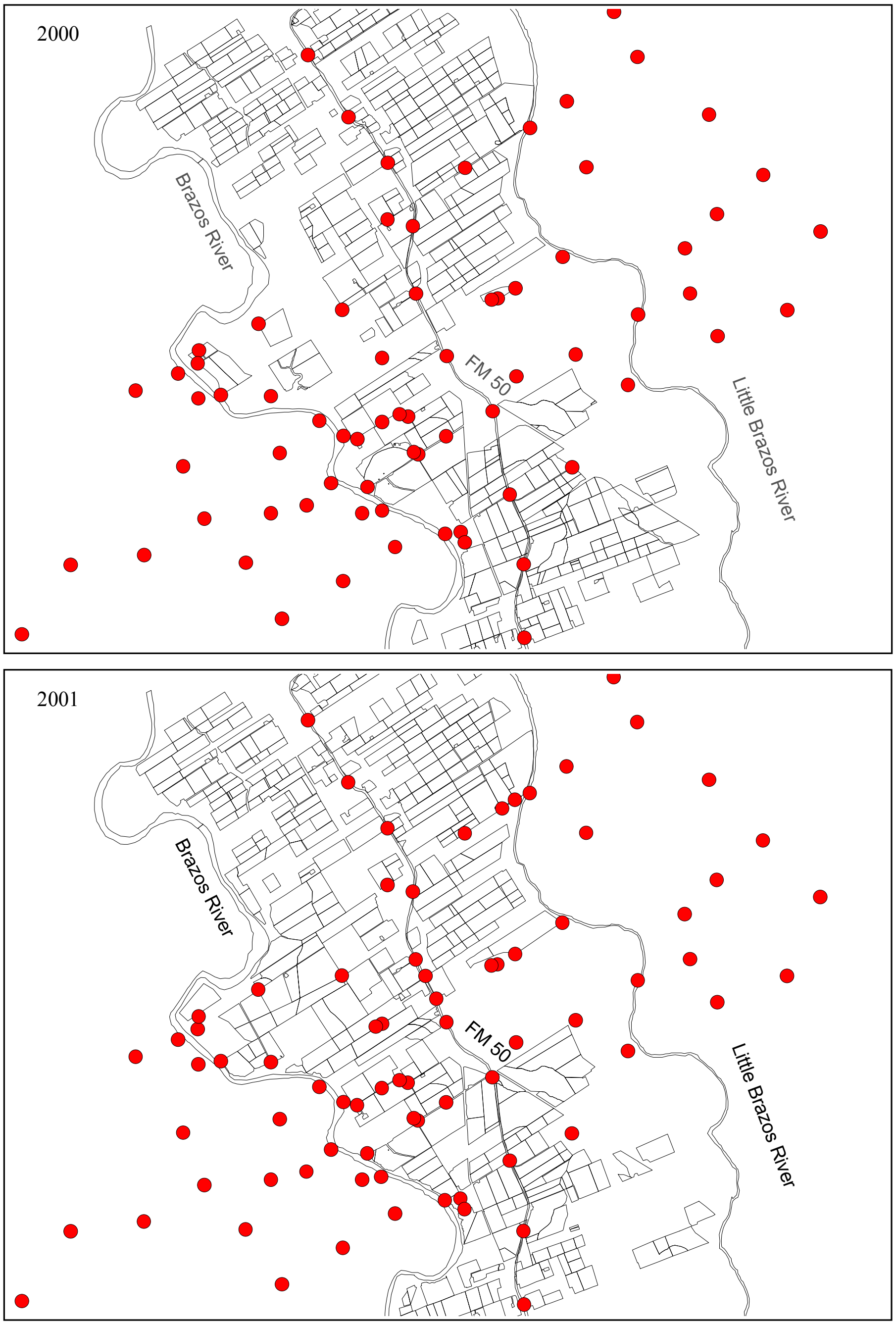

Figure 1. Maps of cotton fields and boll weevil pheromone traps in the Brazos Valley near Mumford, TX, 2000-2001. Cotton was grown only between the Brazos River and the Little Brazos River. The maps cover an area of 15 km by 20 km.