IDENTIFICATION OF BOLL WEEVIL OVERWINTERING HABITAT WITH REMOTE SENSING

Mary P. Maret and Donald R. Johnson
Cooperative Extension Service, University of Arkansas
Little Rock, AR

Abstract

Early season boll weevil infestations in cotton are often high near wooded areas. Satellite spectral data was used to identify and locate wooded zones near cotton fields in three cotton producing areas in Arkansas. Boll weevil densities (as calculated from four years' of intensive pheromone trap sampling) were also mapped for each year in each study area. Areas with relatively high spring weevil densities were almost always associated with wooded zones, indicating that these wooded zones provided high quality overwintering habitat for boll weevils.

Introduction

Circling hundreds of miles above the earth's surface, satellites may be able to provide tools for improved agricultural decision-making. Certain satellites carry sensing systems that act like cameras, measuring light (visible and infrared) reflected from the surface of the earth. Because crops, trees, and other landscape features reflect light in unique ways, satellite spectral data can be used to create color-themed maps of vegetation distribution over large areas. Satellite spectral data may be particularly useful as decision-making tools for landscape-scale projects, such as the boll weevil eradication program in Arkansas.

For boll weevil eradication, pesticide resources could be allocated more efficiently if control practices were concentrated in areas where weevil densities were expected to be high. For example, cotton fields near decidous forest stands or large treelines are often associated with high boll weevil densities in the spring (Beckman 1957, Fye et al. 1958, Rummel and Adkission 1970). These wooded areas are known to be high quality overwintering habitats for boll weevils, a pest of cotton, from where weevils emerge in the spring and infect nearby cotton fields. Satellite remote sensing could thus be used to target early-season insecticide applications to cotton fields near wooded zones. When applied to the general area, such use of satellite data should increase the efficacy of a boll weevil eradication program, while decreasing the program's costs and resource use.

The objectives of this study were to evaluate the use of satellite spectral data for 1) identifying forest areas and large treelines near cotton fields and for 2) predicting where high densities of boll weevils will occur in the spring.

Methods

Satellite images, as generated by computer classification of Landsat Thematic Mapper and SPOT imagery, were obtained from the USDA National Agricultural Statistics Service. These 1997 satellite images had a spatial resolution of 30 meters and covered the major cotton producing areas in Arkansas (Arkansas River and Mississippi delta region). These images were converted using Imagine® (ERDAS, Atlanta, GA) software into a format compatible with Arcview® GIS mapping software (Environmental Systems Research Institute Inc, Redlands, CA.). Areas defined as "cotton" and "woods" by spectral signature were color coded and mapped with Arcview (e.g. Figure 1a).

Three study areas were used to evaluate the use of satellite spectral data for identifying boll weevil overwintering habitat. These study areas were located in three Arkansas counties: Craighead (near Bay), Lonoke (near Pettus), and Mississippi (near Manilla). Each study area consisted of about three to four thousand acres of cotton and included from eight to ten square miles of land area. Boll weevil pheromone traps had been placed at regular intervals (every 200 to 500 yards) throughout each study area and each trap location had been recorded with GPS instruments. Traps were censussed for boll weevils every two weeks during the springs of 1994, 1995, 1996, and 1997. Spring captures from Grandlure-baited traps are strong indicators of emerging boll weevil populations (Carroll and Rummel 1985). For the purpose of this paper, only trap data from mid-May to mid-June (time of peak trap catch) were used.

Catch data were converted to weevil density contour maps (e.g. Figure 2a) with mapping software (ArcView Spatial Analyst). Boll weevil "hotspots" were defined as those areas of the density maps with phermone trap catches averaging 60% or more of the highest average trap catch in the study area for that year. Larger wooded areas, identified from the satellite maps, were circled (e.g. Figure 1b), and the circles were overlaid onto the density maps (e.g. Figure 2b). The number of hotspots associated with larger (circled) wooded areas was compared to the total number of hotspots for each year and study area. Likewise, the number of larger wooded areas associated with a hotspot was compared to the total number of wooded areas.

Results and Discussion

The satellite spectral data at 30-meter resolution allowed us to create maps of crop and vegetation distribution over large landscapes. These maps provided clear graphical presentations of the distribution of cotton fields near wooded areas (e.g. Figure 1).

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:894-895 (1999)
National Cotton Council, Memphis TN

Weevil "hotspots" from mid-May to mid-June were generally associated with the wooded zones identified by our satellite data. (Hotspots were defined as areas with phermone trap catches averaging 60% or more of the highest trap catch recorded for the entire study area). This correlation was especially strong in years when spring weevil pressure was high (Table 1). However, not every wooded area in each study area was associated with a weevil hotspot (Table 2). Generally, there were fewer hotspots than wooded zones, and often there were two or more hotspots associated with the same wooded zone. These data indicate that although weevils overwintered and emerged from wooded areas in greater numbers than from non-wooded zones, not every larger wooded area provided high quality overwintering habitats for weevils.

Overall, the geographical information produced by the satellite spectral data provided a clear visual image of areas where high densities of boll weevils may occur in the spring. These visual resources would be valuable for efficiently allocating boll weevil control resources for a region-wide eradication in Arkansas.

Acknowledgements

The authors are grateful for the support of the Arkansas Cotton Support Committee and Cotton Incorporated in the effort to improve technology to manage the boll weevil. We appreciate the cooperation of the USDA National Agricultural Statistics Service and the University of Arkansas at Little Rock GIS Applications Laboratory for providing, converting and formating the satellite images. We also wish to thank the cotton producers of Arkansas for their cooperation and support of our work.

References

Beckman, C.M. 1957. Hibernation sites of the boll weevil in relation to a small Georgia Piedmont cotton field. J. Econ. Entomol. 50:833-834.

Carroll, S.C. and D.R. Rummel. 1985. Relationship between time of boll weevil (Coleoptera: Curculionidae) emergence from winter habitat and response to Grandlure-baited pheromone traps. Environ. Entomol. 14:447-451.

Fye, R.E., W.W. McMillian, R.L. Walker, and A.R. Hopkins.1958. The distance into woods along a cotton field at which the boll weevil hibernates. J. Econ. Entomol. 52:310-312.

Rummel, D.R., and S.C. Carrol. 1993. Biological basis for a boll weevil winter survival and spring emergence model. Proceedings Beltwide Cotton Conferences. pp. 932-934.

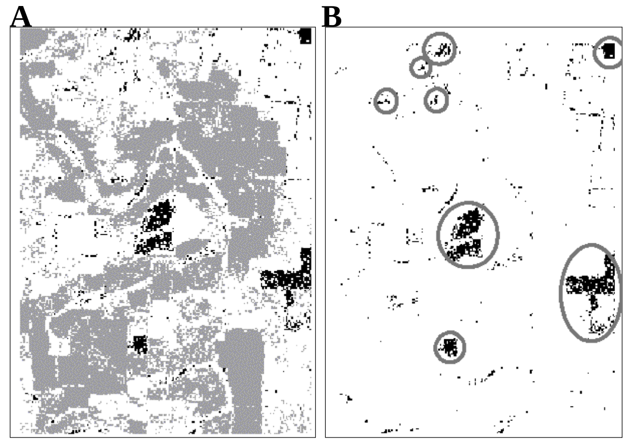

Figure 1a, 1b. Vegetation maps derived from satellite spectral data from 5×8 mile area near Pettus, Arkansas in Lonoke County. Figure 1a shows areas defined as "cotton" in grey and "woods" in black. Figure 1b shows areas defined as "woods" in black with grey circles around the larger wooded areas.

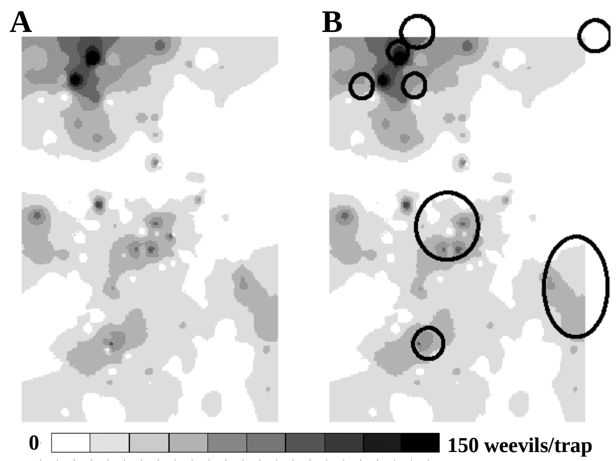

Figure 2a, 2b. Weevil density contour maps from 5×8 mile area near Pettus, Arkansas in Lonoke County (A and B) with circles around larger areas defined as "woods" (B) from satellite spectral data. Densities were calculated from pheromone trap catches (censussed every two weeks) during May and June, 1994.

Table 1. Occurrence of boll weevil "hotspots" near wooded areas in three Arkansas study areas over four years. Hotspots are defined as areas with phermone trap catches averaging 60% or more of the highest trap catch recorded for the entire study area during mid-May to mid-June. Weevil pressure was categorized as high, medium (med.), and low based on the average spring trap catches for each year.

Spring of	Occurrence of "hotspots" near wooded areas					
Year	Craighead		Lonoke		Mississippi	
1994 (med.)	3 of 3	100%	4 of 4	100%	3 of 3	100%
1995 (high)	5 of 5	100%	13 of 14	93%	2 of 2	100%
1996 (low)*	3 of 3	100%	3 of 4	75%	1 of 3	33%
1997 (low)	3 of 4	75%	4 of 5	80%	2 of 4	50%

*Craighead County had medium to high weevil pressure in 1996.

Table 2. Occurrence of wooded areas near boll weevil "hotspots" in three Arkansas study areas over four years. Hotspots are defined as areas with phermone trap catches averaging 60% or more of the highest trap catch recorded for the entire study area during mid-May to mid-June. (Occasionally, one wooded area was associated with two or more hotspots.) Weevil pressure was categorized as high, medium (med.), and low based on the average spring trap catches for each year.

Spring of	Occurrence of wooded areas near "hotspots"					
Year	Craighead		Lonoke		Mississippi	
1994 (med)	2 of 7	29%	6 of 8	75%	2 of 2	100%
1995 (high)	2 of 7	29%	8 of 8	100%	1 of 2	50%
1996 (low)*	1 of 7	14%	1 of 8	13%	1 of 2	50%
1997 (low)	3 of 7	43%	2 of 8	25%	2 of 2	100%

* Craighead County had medium to high weevil pressure in 1996.