ACTIVITIES OF THE MISSISSIPPI BOLL WEEVILGEOGRAPHIC INFORMATION SYSTEM AND SATELLITE IMAGING - 1996

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Abstract

This manuscript describes the use of a Geographic Information System (GIS) developed by the USDA-ARS, Integrated Pest Management Research Unit at Mississippi State, Mississippi. This project came from the need to make management decisions for the Boll Weevil Eradication Program. The GIS was custom developed to meet the needs of this program.

The goals which were met during the development of the software package are discussed. Considerations concerning the implementation of a state-wide insect monitoring program using this software are identified.

Introduction

USDA-ARS, the agency that developed the cotton insect Geographic Information System (GIS); USDA-APHIS, the action agency of the Boll Weevil Eradication Program; the Mississippi Cooperative Extension Service; The Mississippi Boll Weevil Management Corporation, a coordinating entity composed of cotton producers; and Cotton Incorporated; began a program in 1992 to monitor boll weevil infestations in the cotton growing areas of the state. This three year program has been extended and will begin its sixth year in 1997.

The use of GIS technology allows the display of a map on the computer screen that is linked to displayed tabular data and has become widespread. Harlow and Lang (1988) discussed the early development of GIS technology and listed some of the companies that were involved in that development. The use of this type of software in agricultural land use surveys was further described in the American Farmland Trust (Anon. 1985). Many of the concepts used in the development of GIS software were discussed in a publication by Joseph K. Berry (1988). In early GIS programs maps were commonly employed as graphic images. Now satellite images with their extensive data are available to the GIS user. These data include longitude and latitude values for all points on the image, and various bands of information from the electromagnetic spectrum.

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Information, based on GIS data in combination with survey data on cost of boll weevil control, can be used to identify areas, either counties or districts, in which weevil infestation levels and control costs warrant either inclusion or exclusion in an initial boll weevil eradication/management program in Mississippi. Isolated infestations are located and the limits of the generally infested areas are defined.

The Mississippi Boll Weevil Program - During 1990 and 1991, a program was developed in Mississippi to manage the boll weevil and other insect species in cotton. This program has several objectives; two examples are: To eradicate/suppress/manage these insects using the best available technology, and to develop strategies best suited to the diverse and unique geographic and economic features of the state.

Boll weevil populations are measured using a volunteer trapping program. This trapping program is coordinated through the county Extension offices of all cotton-producing counties using boll weevil pheromone traps. These volunteers place boll weevil traps in their fields for a ten week period during the summer. Traps are placed one per field or one per one hundred acres depending upon field size. These traps are checked and rebaited every two weeks during the ten week period. Maps are provided to growers to mark trap location and GIS numbers are assigned. Trap catches are reported to the county Extension office or directly to the MS Boll Weevil Management Corporation.

During the 1996 trapping season approximately 10,000 individual trap catches were received. County and State maps were generated from this data. Figure 1 shows the 1996 State map. This state map provided a visual reference to high levels of infestation, geographic region of populations, potential over-wintering sites and development of hot spots of weevil infestation.

The State and county maps are useful in providing cumulative, end of the year information. It became apparent that there was a need for information during the growing season to allow growers and consultants to make decisions in a more timely manner. During the 1995 and 1996 growing seasons, in cooperation with the MS Cooperative Extension Service five trap lines were set up across the state to monitor four different types of cotton pests, boll weevils, beet armyworms, boll0woms, and tobacco budworms. During the trapping season trap line counts reached 4,600 individual entries. The trap line for the boll weevil alone, required 247 entries per week during the growing season.

The volume of data made it necessary to find an efficient way to get the information to the growers in the area. Figure 2 is a copy of the weevil map for the trapping week ending, October 24, 1996. This graph revealed something that had not been apparent in the raw data. For the first time weevil counts along the Mississippi River were higher than anywhere else in the state. This was attributed to pressure from boll weevil eradication efforts to the east and the wide spread use of a

genetically engineered cotton (bt cotton) developed by Monsanto this year. This bt cotton is developed to be worm resistant, this resistance leads to fewer pesticide applications, thereby allowing for population increases in the weevil.

The success of the Mississippi project led to MS Boll Weevil Management being asked to do the same type work for the state of Tennessee. In 1995 and 1996 growers in western Tennessee participated in a volunteer trapping program modeled along that of Mississippi. At the end of the growing season their data was transmitted to MS Boll Weevil Management. This information was entered into a data base and a map generated based on those entries (Figure 3). For many years opinion had been that winter temperatures in the northern half of Tennessee were too cold for the weevil to thrive. Trap catches, as represented by the Tennessee map make a dramatic statement to the contrary.

The maps of Mississippi and Tennessee, and the most current trap line maps and data tables are available to growers, county agents and other interested parties on our internet web site, ftp://ces.msstate.edu/pub/ces/msbwmc.

The incorporation of satellite images into the MS Boll Weevil Management GIS is a necessary technological jump if we are to move from the current level of geographic definition to the use of agricultural fields as the geographic areas in which a population of insects can be identified. In the past we have used sections, usually one square mile (640 acres), as the smallest areas that could be identified on our maps. This has served well however, some fields may have higher infestations in a particular section, and farmers and insect control managers need to have this infestation information. Satellite images currently offer the only economically viable means of obtaining accurate maps of all of the agricultural fields over a large area.

The satellite images have been purchased, and we are currently working on the technical aspects of integrating the images into the GIS. Two commercially available computer programs that will manipulate the images, have been acquired. We are currently working with both of them to see which will best fit into our GIS protocol.

Satellite image maps of fields have been mailed to selected growers and they were asked to identify their fields and supply the names that they use for these fields. It is necessary in our GIS database that we have the farmer identified with particular fields. This gives us a link between the tabular data (# of insects, etc.) and the geographic data (the maps) that is necessary for the operation of the GIS. After this pilot effort in a few counties it should be relatively easy to expand the program to all of the cotton growing areas of the state.

Preliminary work indicates that cotton can be successfully identified using these satellite images. Work is in progress to identify fields in selected areas of the state.

Development of the GIS - Development of the GIS to present linked tabular and spatial data began approximately five years ago in anticipation of the program such as the one outlined above. This effort has been described previously by Wiygul et al. (1994), and Wiygul and McCarty (1995). The development of the GIS has continued to meet the changing needs of the program. The aspects of the program which are receiving the most requests for change are described below. County and state maps have been produced over the last five years showing boll weevil populations in the cotton growing counties. Different colors have been used on the computer generated maps to show the different numbers of boll weevils per acre. The information presented on the maps has been compiled at the section level (640 acres). A section is usually one mile square, and is a legally defined area. The use of this geographic area as a basis for the maps used in this program have proved satisfactory for most purposes; however, there are some needs which have not been met by this level of definition. The use of maps presenting individual cotton fields, and the availability of tabular data to go with these maps, will increase the usefulness of data obtained from the GIS. The computerized generation of maps with this level of definition is no small task and will be realized with the aid of other technical developments. Satellite imagery is available for any part of the United States and is probably the ultimate solution for availability of maps in GIS work. The U. S. Landsat satellite remote sensing project has provided a variety of satellite images for GIS work for years. Thematic Mapper data from seven different regions of the electromagnetic spectrum are available. These bands can be combined to provide information on water, vegetation, roads, etc. Computer software is available to manipulate these images. With these resources tailored to fit within the framework of our software, we should be able to increase the versatility and usefulness of our current GIS. The Mississippi Boll Weevil Management Corp., recently purchased satellite images of the cotton growing areas of the state. We are working on a protocol to use these images to locate cotton fields. The maps generated with the help of these images will produce boll weevil infestation data for individual cotton fields.

In Review

Implications of the data obtained from earlier years of the program were discussed by Smith and Wiygul (1994), and Wiygul and McCarty (1995). Differences have been observed in boll weevil populations (Fig. 1, 2, 3) in virtually all areas of the state in each of the five years of the program. This shows the value of the data that a program of this type can generate. Currently there are plans to continue operation of the program in 1997 in both Mississippi and Tennessee. The addition of satellite technology and software to manipulate these images should enable the Mississippi Boll Weevil GIS Project to provide even more useful data.

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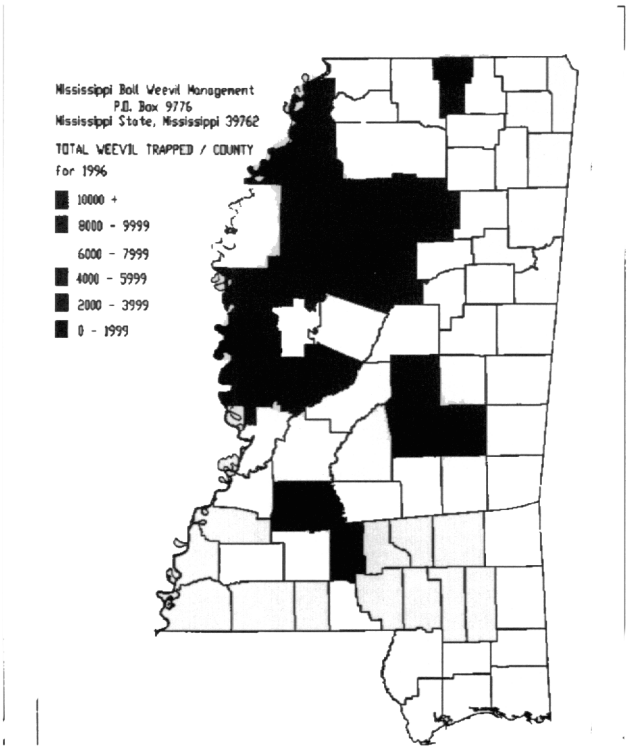

Figure 1 - Trapping results for Mississippi 1996

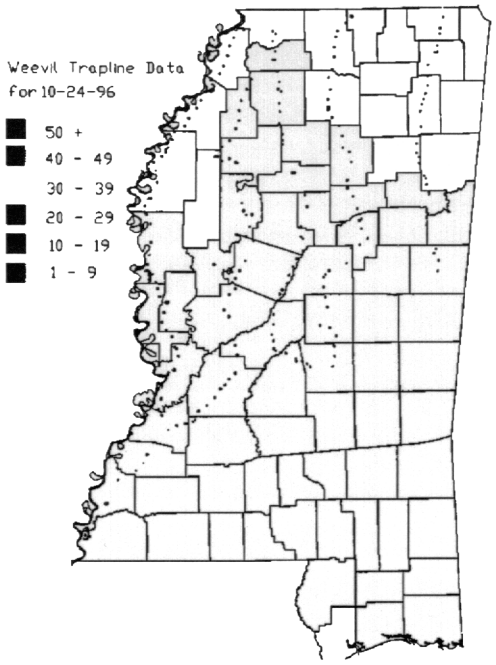

Figure 2 - Trapline map period ending October 24, 1996.

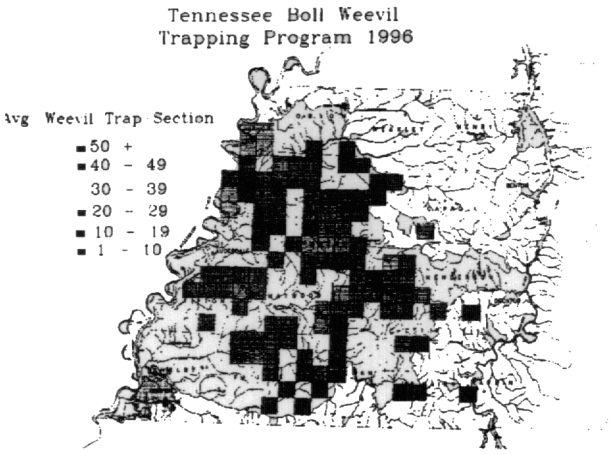

Figure 3 - Map showing results of Tennessee trapping program 1996.