Spatial Mapping of Adult Corn Earworm and European Corn Borer Populations in New Jersey

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SUMMARY. In 1998, Rutgers Cooperative Extension (RCE) and the Grant F. Walton Center for Remote Sensing and Spatial Analysis (CRSSA) at Rutgers University began a joint program to use global positioning system (GPS) and geographic information systems (GIS) technologies to map the spatial distribution of corn earworm (*Helicoverpa zea* Boddie (Lepidoptera:Noctuidae)) and European corn borer (*Ostrinia nubilalis* Hübner (Lepidoptera:Pyralidae)). In 1999 the Rutgers Cooperative Extension Vegetable Integrated Pest Management (IPM) Program operated a network of 81 blacklight insect survey traps in New Jersey. These 15 W blacklight traps were used to monitor adult populations of vegetable crop pests including corn earworm and European corn borer. All blacklight

earworm and European corn borer population data were imported into a GIS software package, and then linked to corresponding mapped locations throughout New Jersey. State wide spatial distributions of adult corn earworm and European corn borer populations were produced weekly, and distributed via extension newsletters and web sites to augment the current RCE IPM outreach program.

European corn borer (ECB), and corn earworm (CEW), are annual pests of vegetable crops in New Jersey including sweet corn (*Zea mays* L.), lettuce (*Lactuca sativa* L.), snap beans (*Phaseolus vulgaris* L.), lima beans (*P. lunatus* L.), and peppers (*Capsicum annuum* L.) (Garrison, 2000). Larval infestations of these pests often result in significant crop losses. The European corn borer overwinters successfully in New Jersey, and is primarily a multivoltine insect with two to three flights occurring during a season (Prostak, 1995a). The corn earworm can overwinter as far north as southern New Jersey, and gradually increases in numbers beginning in early summer (Prostak, 1995b). Extreme increases in CEW often occur in New Jersey as a result of late season storms of southern origin. Adult ECB and CEW females deposit eggs on host crops, which become infested as the larvae hatch and quickly penetrate the corn ear, pepper fruit, or other host. There is often limited time between egg hatch and larval penetration, therefore timing of insecticide applications is critical for obtaining adequate control of these pests. Insect survey traps are commonly used to determine the level of adult ECB and CEW activity. Insect population data, combined with economic thresholds for various crop hosts can serve as a basis for pest control decisions in an IPM program. An economic threshold is the density or intensity of a pest at which management action should be taken to prevent losses greater than the cost of control from occurring (Pedigo, 1989). Growers are advised on when or how often to treat host crops with insecticides preventatively, or monitor for the pests based on the adult trap catches of ECB and CEW in a given geographical region. The Rutgers Coop-

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erative Extension Vegetable IPM Program publishes trap catches by location in weekly newsletters and on the Rutgers Cooperative Extension web site (<http://www.rce.rutgers.edu/pubs/plantandpestadvisory/1999/vegetable.html>).

The objective of the cooperative effort between the RCE Vegetable IPM Program and CRSSA was to utilize the insect survey trap network to provide a management tool to the agricultural community that was timely, accurate, and easily accessed and interpreted. Liebhold et al., (1993) reviewed GIS uses in entomological studies. Recent advances in rangeland and forest management as well as crop production have included the use of GIS technologies for analysis and modeling of insect pest populations influencing those commodities. Wireworm (Coleoptera:Elateridae) habitat modeling based on soil moisture (Lefko et al., 1998), and predictive damage models for gypsy moth (*Lymantria dispar* L.) based on previous years trap catches (Gage et al., 1990) are examples of such uses. GIS software enables the production of maps where many types of spatially referenced data may be superimposed on a geographical surface. Tappan et al., (1991) used GIS technology to produce maps of potential desert locust (*Schistocerca gregaria* Forskal) and Senegalese grasshopper (*Oedaleus senegalensis* Krauss) habitat in western Africa, thereby predicting where egg laying and nymphal stages were likely to occur. Such maps can serve as timely, easily interpreted management tools when current insect pest populations are spatially referenced and updated frequently. For such a system to be effective there must be a sufficient data collection and dissemination infrastructure in place. In 1998, Rutgers Cooperative Extension and CRSSA at Rutgers University began a program aimed at utilizing GPS and its related technology-based tools; GIS and remote sensing, for agriculturally related projects. In the summer of 1999, these tools were used to complement the RCE Vegetable IPM Program by mapping the distribution of ECB and CEW across the state. This is a report on the first year of implementation of this program.

Materials and methods

A grower supported network of

15 W blacklight insect survey traps (Old Boys Enterprises Inc., Oregon, Wis.) (Fig. 1) was deployed on participating farms in April and May of 1999 as part of the RCE Vegetable IPM Program. The location of each trap was mapped using a handheld Trimble GeoExplorer II (Trimble Navigation Ltd. Sunnyvale, Calif.) GPS unit with 2 to 5 m (6.6 to 16.4 ft) accuracy after differential correction. A total of 81 trap sites were mapped in 1999. The traps were well distributed throughout the agricultural areas of the state with fewer located in the largely urbanized northeast and in southeastern regions of New Jersey that are characterized by the sandy soils of the Pine-lands and the coastal shore (Fig. 2). Field technicians were hired, trained and managed by Vegetable IPM Program staff for collecting and reporting blacklight data. RCE Vegetable IPM Program staff verified insect trap catches. Blacklight traps were checked two times a week, at 3 and 4 day intervals. Mean nightly numbers of CEW and ECB adults per trap were determined for each sample period. Weekly means were then calculated and imported into ArcView GIS (Environmental Systems Research Institute, Inc. Redlands, Calif.) and linked to the corresponding trap locations. The data were then interpolated to a grid using an inverse distance weighted (IDW) algorithm, where grid cell values are most influenced by the nearest data points. Each sample value used in the interpolation retained its initial value making this an exact interpolator. This technique produced surfaces with clearly delineated zones representing uniform pest populations while maintaining discrete pest "hot spots" where they occurred. Surface maps of each pest population were produced using specific economic thresholds as a means for classifying the data. Finished maps were published in the weekly RCE Plant and Pest Advisory Newsletter, Vegetable Crops Edition.

This publication was available via direct mail, automated fax system, and the RCE web site. The process, from receipt of data, to publication took about 3 h.

Results and discussion

Mapping pest distributions using GIS/GPS was useful for displaying where and when significant pest populations occurred. The hot spots, discrete areas of higher ECB or CEW activity, identified on the mapped surfaces allowed field technicians and consultants to direct their IPM efforts to appropriate locations. A total of 20 sets of maps were produced and published for CEW and ECB, beginning 19 May 1999 and ending 22 Sept. 1999. Spatial distributions for ECB clearly showed a buildup and decline in the adult population for the first generation (Fig. 3 A–D) and the onset and increase of second and third generation activity (Fig. 4 A–D). These images also show perennial hotspots, such as distinct, early generation foci of activity in the Salem County region

Fig. 1. Blacklight trap.

Fig. 2. Distribution of 1999 black-light trap network in New Jersey; 30 miles = 48.3 km.

of southwestern New Jersey (Figs. 3A and B, 4A and B). This area historically has higher annual activity for each adult generation than the rest of the state. Spatial CEW distributions showed a gradual increase in adult CEW populations as the growing season progressed (Fig. 5 A–D), with sharp population increases following weather systems of southern origin (Fig. 6 A–D). The latter phenomenon occurs when low pressure systems carry CEW adults to New Jersey from southern states, as occurred on 13 to 14 Aug. Population changes, whether through the progression of ECB generations or through migratory influxes of CEW, are important events for vegetable growers since control decisions

in IPM programs are often based on susceptible crop stage and pest population.

Dissemination of pest population information to growers is critical to the success of IPM programs. CEW and ECB maps were accompanied by information relevant to specific economic thresholds for each pest and host crop as well as appropriate monitoring and control strategies (Garrison, 2000; Kline, 2000; Prostack, 1978). For example, an average of 0.5 to 1 adult ECB per night is the level at which pepper fruit begin to be at risk for larval infestation. Greater than five adult ECB per night suggests that snap beans in the bloom and pinpod stages should be treated with insecticides to prevent larval infestations. For CEW, adult populations up to 0.25

per night may indicate that a 6-d spray schedule to protect sweet corn in the silking stage is advisable. A level of 0.8 to 8 per night warrants a 3-d silk spray schedule, and greater than eight CEW per night indicates that crops such as tomatoes, peppers, lettuce and lima beans are at significant risk of larval infestation and should be monitored intensively to determine if control measures are necessary.

Pest data were collected during the week and processed for publication on Wednesday throughout the season. Data processing took approximately 2 h to complete. Current ECB and CEW population maps were available for viewing or downloading on Wednesday afternoons at the RCE homepage. The maps were also published as part of the Vegetable Crops Edition of the Plant and Pest Advisory, which was posted on the RCE web

Fig. 3. Distribution of European corn borer (ECB) based on blacklight samples. (A) week ending 19 May 1999; (B) week ending 2 June 1999; (C) week ending 23 June 1999; (D) week ending 30 June 1999; 10 miles = 16.1 km.

site, and sent to subscribers via an automated fax system or regular mail on Thursdays. The 1999 Vegetable Crops Edition of the Plant and Pest Advisory had a circulation of 331 subscribers. The electronic version (PDF format) of the same publication recorded 1358 downloads during the same period. By accessing maps at the RCE homepage

or through an automated fax system, interested parties were able to receive critical pest information in as little as 1 d after the actual pest sample period. This rapid turnaround time between data acquisition and dissemination allowed growers, consultants and industry personnel to receive critical pest information in the timeliest manner.

Fig. 4. Distribution of European corn borer (ECB) based on blacklight samples. (A) week ending 7 July 1999; (B) week ending 14 July 1999; (C) week ending 28 July 1999; (D) week ending 4 Aug. 1999; 10 miles = 16.1 km.

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Fig. 5. Distribution of corn earworm (CEW) based on blacklight samples. (A) week ending 2 June 1999; (B) week ending 23 June 1999; (C) week ending 14 July 1999; (D) week ending 4 Aug. 1999; 10 miles = 16.1 km.

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Fig. 6. Distribution of corn earworm (CEW) based on blacklight samples. (A) week ending 18 Aug. 1999; (B) week ending 25 Aug. 1999; (C) week ending 8 Sept. 1999; (D) week ending 15 Sept. 1999; 10 miles = 16.1 km.

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