M.M. Ellsbury and R. Krell SSMG-27

Spatial Variability in Corn and Soybean Insect Pests: Precision Farming and Insect Pest Management for the Future

Summary

Public and private research effort is being invested in site-specific insect pest management, but progress in this area lags behind other aspects of site-specific agriculture. Intensive grid-sampled information about insect dispersion in soybean and corn fields provides valuable knowledge, but the usefulness of the information is overshadowed by problems related to implementing precision farming programs for insects. The existence of field level spatial variability in populations of key pests of soybean and corn suggests that a site-specific approach to IPM is possible. The necessary GIS/GPS capabilities are available, but have not been effectively combined into systems incorporating economical scouting methods or real-time monitoring and mapping of pest variability. It has been suggested that optical sensors might be applied to detection of canopy-dwelling insect pests such as the bean leaf beetle. Targeted sampling can be directed by analysis of remotely sensed aerial images that identify anomalous areas indicative of severe pest infestations, provided the cost of the imagery can be kept at reasonable levels and still provide rapid turn around. It will take time to overcome the barriers associated with site-specific insect management, but because of the potential benefits of this technology, research in this area will continue to move forward.

Precision management of insect pests in corn and soybean is not as highly developed or studied as precision soil fertility or weed management. The goal of this guideline is to discuss spatial variability of bean leaf beetles and corn rootworms and to summarize the unique problems and expectations for a precision agriculture approach to integrated pest management (IPM) for these pests.

Distributions of pest populations usually are considered as an average number of insects per unit area or per sample unit for an entire field. This number may change through time as the pest population develops. In reality, the actual distributions vary spatially at any given moment. That is, they are not constant over the entire expanse of a field because landscape, soil, and environmental characteristics are not constant within a field. It is precisely because insect distributions are not constant within a field that site-specific approaches to IPM may be considered. However, uneven and patchy insect distributions make economical and reliable sampling, modeling, or management strategies difficult to develop at the scale and intensity required for site-specific IPM.

Research projects on bean leaf beetles at Iowa State University, Ames, and corn rootworms at South Dakota State University and USDA-ARS, Brookings, seek to answer questions related to these problems. The soybean study was performed in 30 to 50 acre areas within soybean fields, and the corn studies were conducted in 160 acre fields on land operated by cooperating farmers. One aspect of this research involved looking at spatial relationships between insect dispersion in fields and landscape attributes. This type of information may help farmers determine where the worst insect problems are located so that scouting can be focused on those areas. A computer spreadsheet model was used to compare potential gains from a site-specific management program for soybean insects with traditional whole-field integrated pest management.

Spatial Variability in a Soybean Pest—Bean Leaf Beetle

The bean leaf beetle is one of the most important soybean insect pests in the Midwest. Bean leaf beetle population dispersion was examined as part of on-farm site-specific management studies in Iowa. Beetles were sampled on a 0.5 acre grid in 30 to 50 acre field areas, and interpolated maps of their dispersion were created. Using such maps, farmers may be able to identify persistent areas of pest infestation within a season or over multiple years and focus on those areas during insect pest management efforts. Once a persistent insect problem has been identified, the next step is to determine what factors

The Site-Specific Management Guidelines series is published by the Potash & Phosphate Institute (PPI) • Coordinated by South Dakota State University (SDSU) • Sponsored by the United Soybean Board (USB) and the Foundation for Agronomic Research (FAR). For more information, call (605) 692-6280. www.ppi-far.org/ssmg

cause the pattern. Evidence for spatial persistence of bean leaf beetles has been found both within a season and over multiple years (**Figures 1 and 2**). In two central Iowa fields, high beetle density (**Figure 1**) was associated with areas where plants were shorter and soybean cyst nematode density was high. In a western Iowa field there were no soybean cyst nematodes, but high beetle densities (**Figure 2**) were associated with areas with fewer weeds. Beetle populations were aggregated in all fields, but other field attributes associated with the beetle aggregations were different among fields. Site-specific information about relationships and interactions between factors, such as bean leaf beetles and soybean cyst nematodes, that affect crop yield is a powerful way that precision farming technologies may help farmers of the future to coordinate IPM efforts for multiple pests.

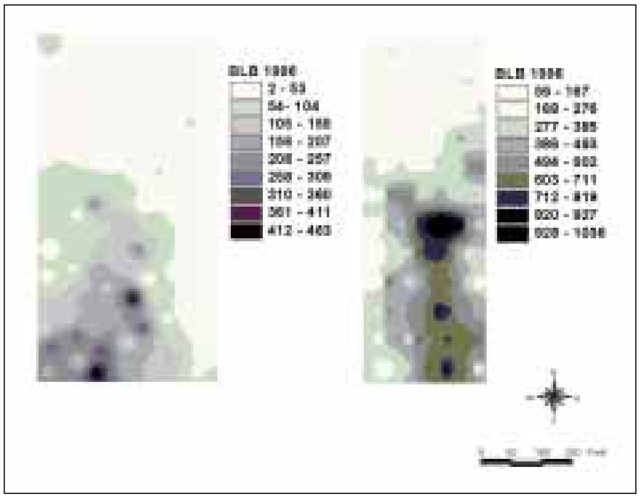

Figure 1. Bean leaf beetle (BLB) population dispersion in study areas of a central Iowa soybean field during September of two different years (1996, 50 acres; 1998, 32 acres). Populations were aggregated in the southern portion of the fields in both years.

Information from the Iowa State University study was used in a computer spreadsheet model to examine the potential return from a precision IPM program targeted to second generation bean leaf beetles in soybean (**Table 1**). Initial start-up costs for precision farming technologies were not included in the analysis. Calculations of net return per acre were based on the average price of soybeans and field-collected yield data in each year. Loss from bean leaf beetles was estimated from actual field populations and knowledge gained from past research on soybean consumption by bean leaf beetles. Uniform insecticide treatment during 1997 produced an increased net return because the whole-field beetle population was above the economic injury level (EIL). In 1998, the field mean beetle population was below the EIL, and treatment would have resulted in a slight net loss. In both years, a site-specific approach, ignoring sampling costs, would have resulted in an increased net return. However, when estimated sampling costs were added to other site-specific management costs the expense of intensive sampling negated any benefit from site-specific management.

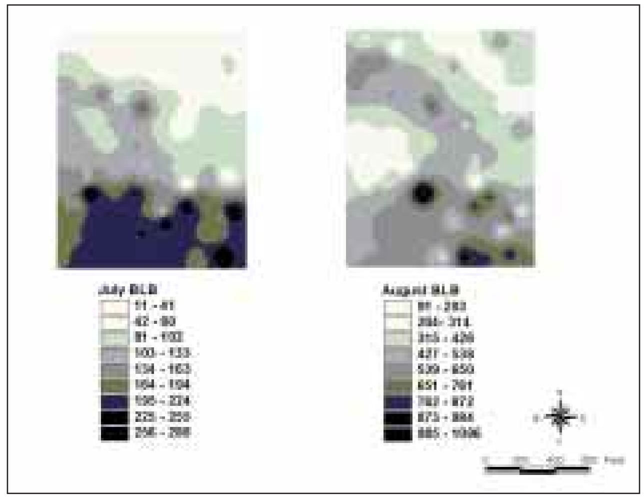

Figure 2. Adult bean leaf beetle (BLB) dispersion in a 30-acre western Iowa soybean field during July (left) and August (right) of 1998. Populations were more concentrated in the southern portion of the field in both months.

Scouting for insects is a time-consuming task, but with the need for increased samples in a precision farming program, scouting time increases even more. Furthermore, the insects collected must be counted and identified in the field. Presently, methods to scout for soybean insects include the use of devices such as beat sheets and ground cloths that are difficult to implement on the scale needed for grid sampling to support a precision approach to integrated soybean pest management.

Table 1. Comparison between uniform and site-specific management for second generation bean leaf beetle in soybean based on a spreadsheet model incorporating yields, average soybean prices, insecticide treatment costs, and grid-sampled bean leaf beetle densities from typical western Iowa fields. Values are expressed as average increase or decrease in net return per acre.

	Difference in return		
Year	Uniform insecticide treatment vs. no insecticide treatment	Site-specific management (cost of sampling ignored) vs. uniform insecticide	Site-specific management (cost of sampling included) vs. uniform insecticide
1997	+$34.44	+$0.96	-$52.56
1998	- $0.44	+$2.42	-$22.80

Spatial Variability in a Corn Pest—Corn Rootworm

In rotated corn, adult northern corn rootworms show spatial variation in grid-sampled fields (**Figure 3**). Similar spatial patterns occur for adult beetles in mixed populations of northern and western corn rootworms in continuously cropped corn. The lowest emergence densities usually occurred in wetter, low-lying areas or on ridge tops, and the highest densities were found in areas that were more well-drained. Because survival of these soil-dwelling insects is determined at least in part by the soil conditions, information about soil properties gained through grid sampling should be useful for decision-making regarding management of the larval stages of corn rootworm. The soil-dwelling stages of insect pests are ideal candidates for site-specific management because they do not move as do adult corn rootworms and other insects capable of flight. Knowledge about soil properties gained from grid sampling may lead to new ways of predicting the risk of insect infestation and help to target scouting efforts for insect pests by concentrating on high risk areas of the field.

Scouting for corn rootworms usually depends on visual counts of adult insects on plants or monitoring of adult insects with sticky traps during the preceding year. This approach is problematic because management decisions cannot be made on the basis of knowledge about existing infestations. Sampling methodology for post-planting assessment of corn rootworm infestations is not available.

Barriers to Overcome

Despite the potential benefits of site-specific insect management, there are significant barriers to implementation, the primary obstacle being the high cost of obtaining site-specific information about insect pest populations. The cost of manual sampling and scouting in terms of labor and time is a serious constraint to obtaining data at the intensity necessary for accurate characterization of spatial variability in pest populations. Ideally, a capability for real time in-field decision making would allow immediate implementation of timely management practices. Remote-sensing technologies linked to geographic information system (GIS)/global positioning system (GPS) technology offer great promise for near real-time monitoring of pest populations to facilitate map-driven application technology. Digital aerial photography or satellite images offer great potential for identification of insect-stressed plants in areas that may be targeted for intensive sampling. Targeted sampling of insect pests that concentrates on high risk areas of a field may help reduce the number of samples required. The second barrier to implementation is the lack of equipment capable of site-specific insecticide application. Insecticides are the most effective control method for most soybean insects when populations exceed the economic threshold. This presents a problem because late-season insecticide treatments usually are done by aerial application. At present, the technology capable of aerial site-specific insecticide applications is not commercially available. In the corn system, most insecticide application equipment is designed for planting time application, well before assessments of early-season rootworm activity are possible. Precision application of insecticides may need to be done at cultivation time or may require an additional passage of equipment over the field in no-till systems. ■

Acknowledgment

Portions of these studies were funded by the Iowa Soybean Promotion Board. Site-specific management research on corn rootworms was funded in part by CSREES, National Research Initiative grants to South Dakota State University in cooperation with USDA-ARS.

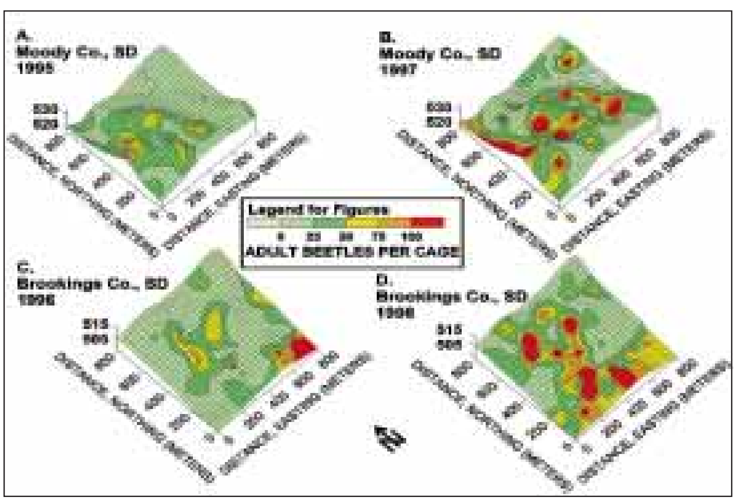

Figure 3. Contour maps for emergence density of adult northern corn rootworm beetles from the soil in two 160 acre corn/soybean rotated fields in eastern South Dakota. Maps A and B, Moody County; Maps C and D, Brookings County. Area under each emergence cage was approximately 0.5 m^2. Crop for each year was corn.

This Site-Specific Management Guideline was prepared by:

Dr. Michael M. Ellsbury
USDA-ARS
Northern Grain Insect Research Laboratory
2923 Medary Ave.
Brookings, SD 57006
Phone: (605) 688-5218
E-mail: mellsbur@ngirl.ars.usda.gov

Ms. Rayda Krell
Graduate Research Assistant
110 Insectary
Department of Entomology
Iowa State University
Ames, IA 50011
Phone: (515) 294-9958
E-mail: rkrell@iastate.edu

Ref. # 99148/ Item # 10-1027