Site-Specific Management Guidelines

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Area-Wide Management Zones for Insects

Summary

Corn rootworm area-wide management is not for everyone. However, if you go into it with an understanding of the potential infrastructure/coordination problems and the knowledge that intense program oversight is needed, it can successfully reduce corn rootworm populations and provide sustainable economic and sociological benefits to the individuals involved. Farmers working together to manage a problem can overcome many of the difficulties that might be encountered. A proactive and futuristic approach to pest management can yield many unexpected benefits related to total farm management.

The concept of area-wide management of agricultural pests is based on a set of principles that are somewhat different from those of traditional integrated pest management (IPM). Definitions of IPM vary widely. However, many individuals regard IPM as "a decision support system for the selection and use of pest control tactics, singly or harmoniously coordinated into a management strategy, based on cost-benefit analyses that take into account the interests of and impacts on producers, society, and the environment" (Kogan, 1998). Most growers currently practice IPM by using the best available pest management tactic(s) as needed against a key pest(s) on an individual field or farm. Area-wide pest management has evolved as a component of IPM and is currently viewed as an effective method to manage pests of economic importance using an organized and coordinated attack on pest populations over large areas (multi-field or farm). Area-wide management is most effective when conducted against a single or small group of pests over large geographical areas that are delineated by biological criteria associated with pest colonization and dispersal potential. Additionally, area-wide management should be coordinated by organizations (groups of people) rather than individuals and should focus on reducing and maintaining a pest population below an economically damaging level.

Area-Wide Management Works With Many Pests

Numerous area-wide pest management programs are currently being conducted throughout the world. For example, fruit flies are being controlled using grower and government coordinated sterile male release programs over wide areas in Argentina, Australia, Costa Rica, Greece, Guatemala, Mexico, Pakistan, Peru, Philippines, Portugal, Thailand, and the U.S. Similar programs are in place for management of tsetse flies in parts of Africa. In the U.S., several cotton pests (e.g., boll weevil, pink bollworm, sweetpotato whitefly, and tobacco budworm) are managed using area-wide techniques. In 1995, the USDA's Agricultural Research Service (ARS) implemented the first formal area-wide pest management program against the codling moth in the Pacific Northwest. That multi-state cooperative program was developed to assess, test, and implement an integrated strategy for the management of the pest on fruit orchards using mating disruption to alleviate the impact of chemical insecticides on natural enemies and to open the opportunity for use of more environmentally friendly control tactics against other pests. Other recent ARS sponsored area-wide management programs are targeted against corn rootworm, leafy spurge, and stored grain insects.

Advantages of Area-Wide Management

Over the past few years many discussions have been held by pest management experts to determine the merits of this novel concept. Out of these discussions, six advantages have been identified:

1) area-wide pest management, when interfaced with IPM programs, offers a long-term solution to the pest problem instead of quick-fix solutions on small acreages;

2) when properly implemented, area-wide pest management can prevent major pest outbreaks and provide a more sustainable management procedure for growers to use;

3) area-wide pest management permits the use of the best and most environmentally friendly management techniques;

4) once fully implemented, area-wide pest management can be more cost effective than managing pests on an individual farm basis;

5) area-wide pest management permits the use of biologically-based management strategies for other pests within the crop; and

6) the basis of an area-wide pest management system is built upon the development of effective pest monitoring systems and reduction in unnecessary pesticide applications.

Corn Rootworm Area-Wide Management and GIS

As IPM expands to area-wide type programs, data management and decision needs become more critical. Pest management using precision farming related tools (e.g., GIS/GPS, remote sensing, etc.) will become more important over large geographic management units. Rapid data assessment and precise decision capabilities will be needed by grower/consultants to adequately manage a crop. The ARS corn rootworm area-wide management program serves as an example of how to use precision farming techniques to manage an important insect pest. The corn rootworm program was implemented in 1996 in response to numerous problems in conventional rootworm management strategies. The program is conducted in Kansas, Illinois and Indiana, Iowa, South Dakota, and Texas on 16 square mile management units, and targets western, northern, and Mexican corn rootworms with insecticide-baits. These baits are composed of a feeding stimulant mixed with small amounts of insecticide. Adult rootworms compulsively feed on the baits and die within hours. The baits can be applied by airplane or tractor mounted sprayer and use about 95 to 98 percent less insecticide than a typical adult rootworm insecticide application. The baits used to manage these highly mobile insects over broad geographic areas prevent significant numbers of eggs from being laid in corn fields. Reducing egg lay can prevent economic infestations from occurring if corn is planted in the same field the following year. This program allows decisions to be made by a site manager that reduce unnecessary insecticide inputs (e.g. prophylactic soil insecticide applications) in producer fields. The management and decision making process involved results in large quantities of information that can best be evaluated using GIS/GPS techniques.

In 1997, staff of the USDA-ARS Northern Grain Insects Research Laboratory in Brookings, South Dakota set out to develop a GIS for tracking crop development, insect management activities, and land use within the South Dakota corn rootworm area wide management site. All fields within the site were mapped with Trimble GeoExplorer II hand-held GPS units. The data were transferred to a personal computer and then exact field locations and size determined using Trimble PathFinder computer software. ESRI's ArcView 3.0 was then used to develop maps and databases of the area.

The information presented here will illustrate the use of precision farming (GIS/GPS) within an area-wide management site. **Figure 1** shows the three types of corn rotations grown within the South Dakota site. Each side of the management area is four miles in length. First year corn rotations are those that have been out of corn production for at least a year. Continuous fields have been in corn production for two years or more, while mixed fields are those that were planted to two or more crops, including corn, the previous year. Note that nearly all first year fields are within one mile of a continuous corn field. This knowledge will play an important role in predicting future adult rootworm movement and infestation levels.

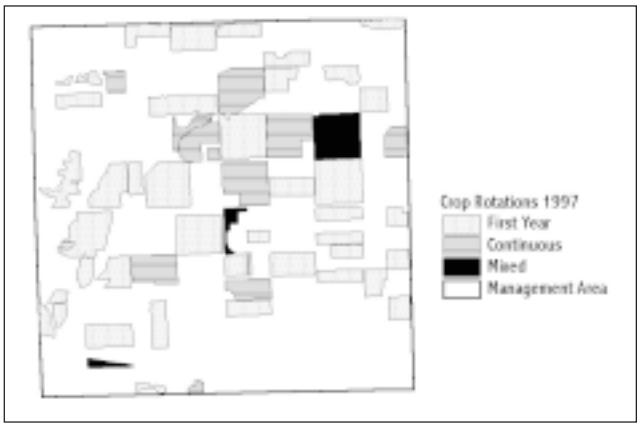

Figure 1. GIS map showing rotational status for fields in the South Dakota corn rootworm area-wide management zone during 1997.

An important need within the management site is the determination of differences in plant growth through the season. Corn rootworm adults move within a field and from time to time to adjoining fields. Beetles are also highly attracted to pollinating corn plants. Pollinating fields that lag substantially behind other fields in development could end up being targets for rootworms to move into in mass in search of food. Tracking crop development through time gives us an indication of mature fields where beetles may be ready to migrate from and younger fields that they might prefer to move into. Insect scouting intensity can be increased or decreased in certain fields to address this issue. For example, **Figure 2** shows the average plant growth stage (based on a numerical research scale with the higher numbers being more mature plants) on August 4, 1997. A single field in the lower left corner is lagging in development and could be a target of late season insect movement.

Tracking insect infestation magnitudes over broad areas can also be accomplished with GIS/GPS related techniques. **Figure 3** shows the average number of western and northern corn rootworms per plant on August 4 (immediately prior to treatment with a bait). Any field with one or more beetles/plant is a likely candidate for treatment. **Figure 4** is a map of the area on August 18 and shows the reduction and/or increase in beetle numbers from the August 4 date. The fields with negative values have increasing beetle numbers, and the fields with positive values have decreasing numbers as a result of bait applications. It is readily apparent that GIS/GPS technology can certainly benefit crop managers in tracking changes in insect density over large areas.

Figure 2. Average corn plant growth stage, South Dakota area-wide corn rootworn management area, August 1997.

Figure 3. Area-wide management fields classified according to counts of corn rootworm adults per plant, August 1997.

Figure 4. Change in counts of corn rootworm adults per plant after application of bait formulation.

Implementation of Area-Wide Programs

The biggest question with corn rootworm area-wide management is how to do it. Conducting a large scale, biologically-based management program initially requires a substantial change in an individual's thought processes. An area-wide management program needs a great deal of coordination among cooperating parties and increased oversight of activities compared to more conventional IPM pest management approaches. Essentially, these programs do not run by themselves. They also may need a substantial amount of monetary support during program startup.

There is no optimum size for an area-wide management program. The size should be based on the number of farmers willing to participate in the program, the type of pest targeted, the crop associated with the pest, the type of management approach used, and the economics to make the system work. For corn rootworms, 16 square mile sites were chosen as a matter of convenience during the initiation of the program. However, the same principles of managing adults using semiochemical-baits can be applied on smaller or larger sections of contiguous corn acres. The key is to keep all the acres within the defined area in the program. A mosaic of participating and non-participating growers across the landscape will not enhance the probability of establishing a successful program.

Area-wide management programs should be coordinated by groups of key participants rather than individuals. Farm cooperatives, agribusiness groups, local grower groups, or perhaps some government established organization could effectively lead the development and implementation of area-wide pest management programs. Coordination of the project is critical. Selection of a site manager(s) by the lead group will be extremely important. This individual will be charged with implementing the pest management program, selecting monitoring procedures and assessment procedures, managing scouts and budgets, and providing communication to participating growers on the outcomes of the program activities. The site manager is key to keeping things together and making the program work.

An area-wide management program must focus on reducing the pest population to acceptable and manageable numbers. For example, in the corn rootworm program, the semiochemical-bait is the key for the program's success. The only bait currently on the market is sold under the trade name SLAM. It is manufactured by MicroFlo Co. of Memphis, Tennessee. The bait is applied at one-fourth to one-half pound of product per acre in a minimum of one gallon of water. It can be applied by air or by ground sprayer in typical broadcast fashion. Applications are made when female beetles are in the field and the beetle numbers caught on yellow sticky traps equal or exceed five per day over a 7 day period. Bait applications made during this critical period can reduce beetle numbers below threshold and limit the number of eggs laid that may infest corn the following year. A similar method can also be employed in soybeans in the central Midwest. In this area, corn rootworm beetles lay eggs in beans. These eggs hatch the following year and can result in severe feeding damage to corn that is planted in the typical bean/corn rotation pattern. Scouting is key for bait applications. You must know the severity of your rootworm infestations to properly target a field or portion of a field that exceeds threshold for a bait application. Scouting should be conducted throughout a field to pinpoint hot spots. A minimum of six yellow sticky traps equally distributed throughout a field (regardless of size) will provide you with adequate information to make a management decision. Naturally, the more traps you can place

within a field gives you better precision. Traps should be collected at least once a week, and information can be entered into computers with GIS software to provide information on movement, changing populations, etc. GIS/GPS is critical for management of large amounts of data generated from area-wide management programs.

The potential for use of precision farming techniques within these areas is only limited by one's imagination. The tools available will become increasingly more sophisticated through time, and the decision processes derived from these tools could lead to widespread adoption of the technology throughout the world. ■

Suggested Reading or References

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