Importance of Designating Prevention and Suppression Control Strategies for Insect Pest Management Programs in Conservation Tillage

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Introduction

Insect pest management (IPM) is a broad concept and is considered from several perspectives by different entomologists. Most would agree that IPM programs usually involve more than one control tactic which are applied in a coordinated manner for the production of a commodity. All and Musick (1986) discussed IPM for conservation tillage systems as "the use of various preventive and suppressive tactics in as compatible a manner as possible while keeping the pest population at levels below those causing economic damage." The independent philosophies of prevention and supression of insect infestions are important in making IPM decisions for conservation tillage systems.

Preventive control utilizes habitat management, judicious crop or cultivar selection, sanitation or prophylactic insecticides to maintain insect populations at low levels. Preventive control involves two important concepts:

1. The realization that cultural procedures or crop cultivars can have either positive. negative. or neutral influences on crop/pest/pest natural enemy interactions: knowledge of all three effects is improtant in making IPM decisions. A cultural practice that has detrimental impact on insects is desirable in preventive programs and is termed **cultural control.** It is equally important to recognize practices that stimulate or have no effect on pest populations so that detrimental measures can he avoided and neutral ones utilized without fear of causing an outbreak.
2. The development and utilization of risk assessments or hazard ratings for specified cropping programs are fundamental for estimating the probability of developing insect infestations. Preventive control tactics usually have low economic risk and are normal agronomic procedures that do not increase the cost of producing the crop. Practices such as use of insect resistant or tolerant crops prcsume that seed cost and crop yield are compatible to other cultivars. Also, planting date selection, tillage practice. etc. must be cost effective for agronomic purposes as well as IPM. Insecticides are used in preventive control programs with the realization that there is a high probability of economic loss without them.

Due to the necessity to keep costs low, preventive control is often the predominant IPM strategy in conservation tillage systems. **Crop and cultivar selection** is the axis of many preventive control programs. The term **prohibitive crop selection** describes the selection of the least susceptible crop for a cropping program with specified pest hazards (All and Musick, 1986). For example, in double cropping conservation tillage systems where a field crop is planted following small grain harvest, use of soybeans often has an advantage over sorghum and corn due to lower relative susceptibility to several pests (Rogers, 1988).

The focus of **cultivar selection** is the use of pest resistant or tolerant varieties. Developing high yielding, agronomically acceptable crop cultivars with good insect resistance is difficult, time consuming work. Consequently, resistant cultivars are not yet available in many crops used in conservation tillage. In cases where insect resistant varieties are not available, IPM specialists should avoid commercial varieties that are highly susceptible and use the most tolerant cultivars available with other control tactics in an integrated program.

Crop rotation is a preventive control method that can he useful for certain insects which are categorized as resident pests. These insects have extended life cycles or restricted feeding behavior. Generally, when these pests establish infestations in a field, they will persist and often increase if the same crop is used year after year. Switching to a non-preferred host suppresses populations by disrupting the biologies or behaviors of resident pests. Crop rotation is not effective on insects categorized as transient pests due to the unpredictability of infestation from year to year. Additionally, these transient insects usually have multiple generations annually or have polyphagous or migratory hehavior and populations move readily among crops.

Habitat Management concerns the use of cultural practices to create enviornments that manipulate the interaction between the crop, insect(s), and insect natural enemies for IPM purposes. If the cropping enviornment has a nagative impact on pest populations, it is termed **cultural control** (Anonymous. 1969). Habitat management also recognizes the importance of cropping environments that have positive or neutral influences on pest populations in making risk assessments for IPM. An illustration is the **manipulation of planting date** for pest control which is based on knowledge of the phenological synchrony of a crop with damaging populations of resident or transient insects. Altering the planting date so that vulnerable crop growth stages do not coincide with peak insect populations is a centuries old IMP practice based on avoiding positive cropping enviornments for pests.

Conservation tillage and various types of **plow tillage**

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influence soil environments and have a major impact on the population potential of certain pests, and these influences may be positive or negative, depending on the insect. For instance, using no tillage enchances the risk of southern corn billbug, *Sphenophorus callosus* (Oliver), infestations in some areas (All el al., 1984), whereas, under other circumstances, losses from the lesser cornstalk borer, *Elasmopalpus lignosellus* (Zeller), are suppressed by conservation tillage (All el al., 1979).

Subsoiling, irrigation, fertilization and other cultural practices that stimulate optimum crop growth are habitat management practices that aid plant tolerance of insect injury. Since these practices often entail considerable cost, they are rarely adopted for the sole purpose of insect control. They are used as viable agronomic practices with the knowledge that they do not create environments that favor the biological potential of pests, and optimize growth of crops while under insect attack (All and Musick, 1986).

Biological control programs in conservation tillage involve habitat manipulation directed at **conservation** (avoiding cultural practices and pesticide use patterns that are detrimental to parasites, predators or pathogens of pests) or **enhancement** (producing cropping enviornments that maximize the biological potential of natural enemies) (Stehr, 1982). Surface debris from former crops in conservation tillage systems appears to benefit carabid beetles (insect predators) (House and All, 1981) and promotes maintenance of high numbers of Steinernemid nematodes (insect pathogens) near the soil surface (Hsiao and All, 1989).

To many agriculturists, **sanitation** is the disposal or destruction of plant debris and other refuse for hygienic purposes in crop fields. For entomologists, the term is narrowed to refer to measures that produce direct mortality to insects. Deep tillage can bury or destroy various life stages of insects residing in crop debris or in surface soil and has long been known as an effective sanitation technique (Anonymous, 1969). There is justifiable concern that lack of soil disturbance in conservation tillage systems provides sanctuary for resident populations of certain pests (All and Musick, 1986). Burning of crop refuse is a sanitation practice often used prior to conservation tillage operations. This procedure probably has some pest control value by killing insects on surface debris and by destroying food sources for pests. Burning has little value for control of subterranean insects because soil temperatures below a few centimeters do not increase more than a few degrees with a fast moving fire over agricultural land (J. N. All, 1989, unpublished data).

Insecticides are often used to protect crops and evidence indicates that they can be utilized effectively in Conservation tillage in a similar manner as plow tillage systems (All et al., 1979, 1984; All, 1988). Prophylactic insecticides are applied in situations where there is proven profitability from suppressing resident insects or when there is high risk of devastation from transient pests. The problems associated with reliance on preventive insecticides are numerous and well documented. Chemicals are expensive, insect populations commonly become resistant, and microbial degradation of certain insecticides may be increased in conservation tillage systems where chemicals are applied numerous times without soil disturbance (Felsot, 1987). Insecticides can be an important tool for conservation tillage IPM, but their use as a preventive control tactic must be mediated with awareness of their limitations.

Suppressive Control Measures

When insect outbreaks occur, preventive control measures do not act quickly enough to prevent economic loss. Application of insecticides by ground or air equipment is the primary tactic for suppressive control programs; research indicates that the methodology commonly used in plow tillage systems is equally effective in conservation tillage (All and Musick, 1986). Unlike many of the preventive control practices, chemical suppression of pest outbreaks has a singular purpose, to kill insects rapidly and efficiently. However, this tactic can be among the most expensive operations in producing the crop. Thus, the decision to deploy suppressive techniques is based on estimates of the magnitude of the pest population and the potential for yield loss without immediate control.

Action threshold (sometimes termed “economic thresholds”) have been established for many of the pests of field crops. These thresholds designate the point at which insecticides must be applied to prevent a current insect population from producing economic loss beyond the cost of chemical control. Insect populations are estimated by a variety of sampling techniques (e.g. crop “scouting,” insect attraction with pheromones or light traps, etc.) and correlations are made with yield loss. At the present time, few action thresholds are based on quantitative studies of the relationship between insect populations and yield loss (Pedigo, 1989). Most are more or less “educated estimates” made by entomologists experienced with insect management in different crops, and no thresholds have been developed for conservation tillage situations. Despite limitations, the use of action thresholds is invaluable in making chemical control decisions and it is probable that the thresholds available for crops in plow tillage systems are applicable to conservation tillage.

Concomitant Cropping Practices

IPM philosophy implies that preventive and suppressive control practices act synchronously to provide the most efficient management program for pest insects (All, 1987). With some modifications, IPM principles developed for crops in plow tillage systems are applicable for conservation tillage. Implementation of effectivepreventive control tactics should be the first priority when developing an IPM system for conservation tillage because these techniques are least expensive and are sound agronomic practices. However, surveillance of insect populations and utilizaion of action thresholds for decisions on suppressive control should be important components of IPM systems for conservation tillage (All, 1989).

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