Soybean Insect Pest Management and Conservation Tillage: Options for the Grower

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Introduction

The use of conservation tillage (CT) practices for soybean production has been relatively recent compared with corn. Development of effective post-emergent herbicides, development of better planters and drills, and the use of narrow rows to aid in weed control have all contributed to the adoption of conservation tilled soybeans. Conservation tillage has many effects on arthropods, both directly and indirectly (Hammond & Funderburk 1985, Hammond 1987). Often it is the direct effect of tillage practices on insect habitat, but more often it is the indirect effect through the presence of weeds or the impact of beneficial insects, both of which are more abundant in CT soybeans. This report will focus on how growers can have an influence on arthropod pests when CT impacts pest population dynamics. The two pests to be discussed in detail, seedcorn maggots (SCM), **Delia platura,** and slugs (a nun-insect pest of soybeans), are pests associated with CT in northern states. An overview of their relationship with CT will be followed by suggested grower practices that can reduce the negative impacts.

Selected Pests

Slugs: Slugs were one pest associated with CT practices a priori, that is, prior to the actually widespread adoption of CT. Indeed. they have become more of a problem in the eastern corn belt states as these practices were adopted. Studies by Hammond (1985) and Hammond & Stinner (1987) have addressed the relationship between slugs and CT. No only was the incidence of slugs highly correlated with the amount of residue left on the soil surface, but the previous crop also had a significant impact on slug populations. More slugs were obtained in no-tillage fields when soybeans were the previous crop compared with corn (Table 1). No specific reasons were given for this difference, although the possibility of a more favorable habitat provided by legumes was suggested. Low slug densities were always found in the conventional tilled plots. The reports stated that the incidence of slug problems were likely to increase as CT practices became more accepted.

Of interest to this discussion is what growers can do to control slugs. Foremost is knowing that reduced tillage increases the potential for slug damage, while incorporating some of the crop residues will limit slugs' ability to cause economic damage. Obviously, this presents a problem for

Table 1. Average number of slugs per trap for interaction between tillage and previous crop in 1984 and 1985.

Previous	Tillage		
Crop	Conventional	Reduced	No-tillage
June 22, 1984			
Corn	0.0 d	0.5 cd	1.8 b
Soybean	0.0 d	0.7 c	3.5 a
May 31, 1985			
Corn	0.3 c	0.8 c	1.6 bc
Soybean	0.1 c	3.6 b	8.8 a
June 14, 1985			
Corn	0.1 c	1.9 bc	3.6 b
Soybean	0.2 c	1.8 bc	11.3 a

From Hammond & Stinner (1987); Numbers within dates followed by different letter are significantly different according to Duncan's Multiple Range Test at the 5% level.

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strict no-tillage growers as they will usually be unwilling to employ any type of tillage. However, the grower willing to employ other CT practices (such as chisel plowing or light disking) which incorporate some of the residue can use that option to assist in keeping slug populations lower (keeping in mind CT by definition is any practice that allows 30% of residue to remain). A recommendation in the Midwestern USA for fields with a history of slug problems would be as follows: If early spring weather is cool and wet, and more of the same weather is forecast into June, incorporate some of the residue to aid in slug control. For those growers unwilling to use any tillage and for those who do but need additional control, they should be encouraged to keep a close watch on their fields, especially when following a legume. When a slug problem occurs, a molluscicide should be used. Although there is only one molluscicide available for controlling slugs in soybeans (a 24 State Label for Larvin applied as a bait), it does offer the grower an option.

Seedcorn Maggot: The association between SCM and CT soybeans bas been studied extensively in Ohio and Iowa for the past 8-10 years (Funderburk et al. 1983, Hammond 1984, Hammond & Stinner 1987, Higley & Hammond 1988, Higley & Pedigo 1984, and Hammond [unpublished data]). Funderburk et al. (1983) showed that no differences in SCM populations existed between in-row and between-row areas, suggesting that the soybean seed was not necessary for the insect to develop and perhaps served only as incidental feeding sites. This incidental feeding can cause economic losses if sufficient. Observations from Ohio (unpublished data) support this finding of high larval and pupal numbers in cultivated soils where no seeds were planted.

The Occurrence of SCM is more dependent on tillage practices and the incorporation of organic matter in the soil, with numbers of SCM varying depending upon the type of organic amendments. A three year study has been completed in Ohio which examined the interaction between tillage and cover crops/residues (unpublished data). Data from 1986 (Figure 1) illustrate results that were obtained during all 3 years. Few SCM adults were collected from no-tillage areas, supporting early studies that showed no-tillage practices do not increase SCM (Funderburk et al. 1983, Hammond 1984, Hammond & Stinner 1987). When organic matter is incorporated, SCM numbers increased dramatically with significant differences obtained between the type of organic amendments. More adults were collected from soils containing incorporated alfalfa, followed by rye, then soybean residue, and corn residue. Data analysis from all **3** years also indicated increased SCM numbers when legume covers/residues are incorporated compared with grass covers/residues.

Studies (Hammond 1984 and unpublished data) suggest that ovipositing female adults are attracted to the soils at the time of tillage, and the number of adults emerging from those soils are independent of the date of soybean planting. Growers who employ no-tillage practices should rarely experience problems with SCM. Those who use cover crops need to be aware of potential problems if those crops are incorporated. When growers opt to incorporate the cover by plowing, disking, or another form of tillage, they should be advised to treat their seed with an insecticide. Seed treatments are the

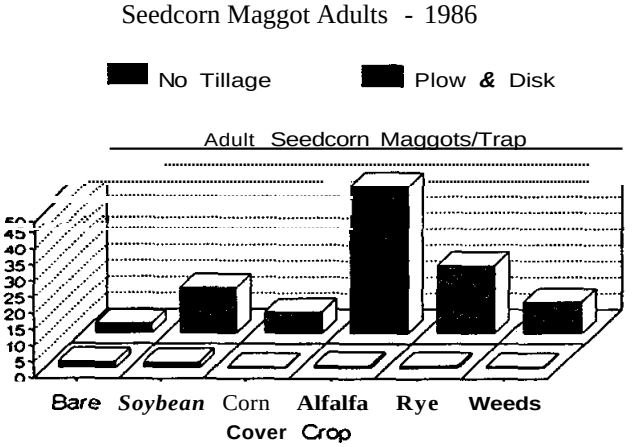

Figure 1. Average number of adult seedcorn maggots per trap in 1986.

most economical method of controlling the seedcorn maggot. Based on Ohio research, this recommendation is especially relevant when a legume is incorporated.

The alternative to using a seed treatment is to either delay tillage and planting until the adults in early May areno longer present, or to till early and then plant the soybeans during a period when the insect is in its pupal stage. Using the first of these options would require monitoring adults which would not be easy for most growers as special sampling techniques are necessary. The second option requires less effort by the grower. When the grower uses this option, not only do they plant when the insect is not feeding, but they plant when the soil is often warmer which would allow for more rapid seed germination. Population dynamics studies suggest that adults emerge after approximately 400 heat units have accumulated following oviposition (Hammond 1984). The insect enters the pupal stage at approximately 234 heat units following oviposition (Sanborn et al. 1982). Assuming that most eggs are laid within a few days of tillage, the majority of the population would be in the same stage throughout its life cycle. Over the past 5-6 years of sampling for SCM, the majority of adults emerge from the soil in late May or early June within days of each other. The recommendation for growers who do incorporate a cover crop in early May is to delay planting soybeans until approximately 234 heat units have accumulated from the time of tillage (see Figure 2). The

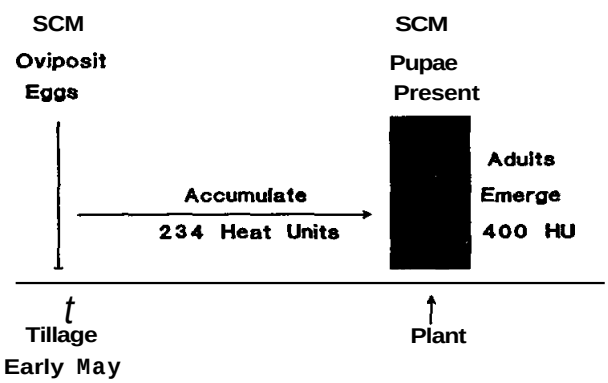

Figure 2. Hypothetical tillage and planting date system for escaping seedcorn maggot damage.

majority of SCM should be in the pupal stage, and the damage potential to germinating soybeans will be minimized.

Adult fly emergence based on time of tillage rather than planting is supported by a second study done in Ohio (unpublished data) where the interaction between planting date and use of various soil insecticides was studied. Soybeans were planted at varying times into soil that had a rye cover crop incorporated in early May (within 24 h of tillage, 1.5 wk later, and 3 wk later). In 1987, the control plots (without any insecticide treatments) which were planted 1.5 week after tillage had equal numbers of emerging SCM flies (21.3 SCM adults per trap) compared with plots planted within 24 h of tillage (21.1 SCM adults per trap). Control plots planted 3 weeks following tillage, although having significantly fewer SCM adults emerge (16.6 SCM adults per trap), nonetheless had a noticeable population. The majority of the adults in the control plots from all three plantings emerged within a 6 day span, with the percentage of adult emergence on each collection date being nearly equal. The percentage of the total number of adults collected per planting date for the first three collection dates were as follows: 1st collection date = 56%, 54% and 41%. 2nd collection date = 18%. 15%, and 20%, and 3rd collection date = 22%, 24% and 27% for the three planting dates, respectively. This is a good indication that oviposition occurred over a relatively small time period, since SCM adults emerged equally from plots planted over a 3 week period. The percentage of plants damaged by the seedcorn maggot decreased with each planting date (1st planting date = 19.6%, 2nd planting date = 8.1%, and 3rd planting date = 6.8%). While the first planting date immediately after tillage had high numbers of SCM and a high percentage of damaged plants, the percentage of damaged plants from the second planting date were significantly less although the number of SCM was equal.

Discussion

Although this report has dealt with situations in the niidwestern USA, its ideas also pertain to the southern USA. Conservation tillage in the southern USA involves numerous agronomically acceptable tillage and subsoiling practices, and as in the midwestem USA, the interactions between various pests and these practices have been studied. Lesser cornstalk borer damage in CT is often greater when weeds and crop residues are burned prior to planting due to soybeans being the only available food source. *Heliothis zea* populations are reduced in CT fields due to the destructive effects of plowing and disking on pupal mortality. Velvetbean caterpillar numbers are lower in weedy soybeans (often associated with CT) due to the greater predator populations and reduced soybean biomass in weedy soybeans. All these relationships offer options such as weed and crop residue burning, light tillage and companion cropping that growers can use to reduce pest populations.

What does the future hold in store? We will see more work on the impact of weeds and companion crops in CT soybeans, not only in terms of yield but also on the interactive effects on pest arthropod populations. We already know of specific situations where grasses can have a significant impact on soybean pests. Both wheat and grassy weeds lowered populations of potato leafhoppers in soybeans in various soybean production systems in studies conducted in Ohio. Perhaps we will develop options that uses such companion plants to lower certain pests to manageable levels.

The area of research having the greatest potential is with beneficial insects which are more diverse and numerous in CT fields. As the biocontrol potential of beneficial insects is better understood, the option of modifying tillage practices to allow for increased predator and parasite activity might be developed. This work is already being explored. Funderburk et al. (1988) recently published work showing higher numbers of bigeyed bugs and damsel bugs, two important predators in the South, in disk tilled soybeans compared with no-tillage systems. The day will come when grower recommendations on the type of tillage to use is done to allow for greater biocontrol of insect pests.

As Herzog & Funderburk (1986) concluded, each crop and pest situation must be evaluated individually and control decisions made for each specific geographic location. The first step is determining the effects of specific tillage practices on both pest and beneficial insects. When those are known, a conscious effort should be made to develop useable options for the grower. Sometimes that option might not be exactly what the grower will want to hear. However, it may not be so far removed as to make it completely unusable. Those are the options that need exploring.

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