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FALL ARMYWORM (LEPIDOPTERA: NOCTUIDAE) INFESTATIONS IN NO-TILLAGE CROPPING SYSTEMS

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ABSTRACT

Field experiments comparing no-tillage and plow-tillage practices demonstrated that infestations by the fall armyworm, *Spodoptera frugiperda* (J. E. Smith), ultimately become similar in either cropping system. However, in certain no-tillage situations where high mulch concentrations were present on the soil surface, oviposition and damage were reduced. Significantly fewer egg masses and damage were sampled on corn, *Zea mays* L., (3-leaf stage) while seedlings remained within no-tillage mulch. Oviposition quickly became similar to that observed in plow-tillage systems when the plants grew above the mulch canopy of no-tillage. The number of egg masses on corn older than 4 leaves was similar in either cropping system, and leaf injury at plant silking was the same. In a comparison of corn, sorghum (*Sorghum bicolor* [L.] Moench.), and soybeans (*Glycine max* L.), the latter crop had no damage in either tillage system while corn and sorghum were heavily infested. Efficacy of chlorpyrifos (0.56 kg [AI]/ha) for controlling fall armyworm leaf damage was similar in corn and sorghum in either cropping system.

RESUMEN

Experimentos donde se comparó el no labrar y el labrar con arado demostró que las infestaciones por el gusano cogollero, *Spodoptera frugiperda* (J. E. Smith), al final, son igual en cualquiera de los dos sistemas. Sin embargo, en ciertas situaciones donde no

se ara y está presente una concentración alta de capa vegetal en la superficie del suelo, se redujo la oviposición y el daño. Significativamente menos masas de huevos y daño se encontró en muestras de maíz, *Zea mays* L., (etapa de 3-hojas), mientras las plantas de semilleros permanecieron dentro de la capa vegetal no arada. La oviposición se igualó rapidamente a aquella observada en el sistema labrado con arado cuando las plantas crecieron por arriba de la capa vegetal cuando no se aró. El número de masas de huevos en maíz más viejo de 4-hojas, fue similar en cualquiera de los dos sistemas de labranza, y el daño a la hoja cuando la mazorca está produciendo seda también fue igual. En una comparación entre el maíz, el sorgo (*Sorghum bicolor* [L.] Moench.), y la soya (*Glycine max* L.), el último cultivo no tuvo daño en ninguno de los sistemas de labranza, mientras que el maíz y el sorgo fueron muy infestados. La eficacia de clorpirifos (0.56 kg [AI]/ha) en controlar el daño a las hojas por el gusano cogollero fue igual en el maíz y el sorgo en cualquiera de los sistemas de labranza.

Entomologists recognize that the crop environments created by no-tillage practices are often greatly different from those of plow-tillage systems and are justifiably concerned about enhanced biological potential of pests like the fall armyworm, *Spodoptera frugiperda* (J. E. Smith), in no-tillage (All & Musick 1986). Increased damage by other noctuids such as the armyworm, *Pseudaletia unipuncta* (Haworth), and the black cutworm, *Agrotis ipsilon* (Hufnagel), in no-tillage cropping systems has been reported (Musick & Petty 1973, Wrenn 1975), and the fall armyworm infests many of the same crops. Therefore, this paper reviews data from experiments designed to determine if fall armyworm hazard is influenced by lack of tillage.

Materials and Methods

Field experiments were conducted during 3 years (1985-1987) near Athens and Griffin, GA. The experiments had either a split plot or split-split plot design. The main plots were preplanting land treatments consisting of some form of no-tillage compared with plow-tillage. The designation 'no-tillage' consisted of treatments in which no plowing operations were used immediately prior to planting of seed. This included planting into fallow land with weed cover and/or debris from former crops. Also, no-tillage treatments were used in double cropping systems where a field crop was planted into standing small grains (including rye, *Secale cereale* L.; wheat, *Triticum vulgare;* and barley, *Hordeum sativum*, or into stubble following harvest of the grain.

Plow-tillage treatments consisted of tilling the soil with either a moldboard plow, disk harrow, or rotary tiller. Soil was tilled up to 5 times in some treatments to insure a smooth seed bed for planting. The size of no-tillage and plow-tillage plots varied from 0.03-0.1 ha with 3-5 replications in different experiments.

The subplots in the experiments were selected crops (corn, *Zea mays* L.; sorghum, *Sorghum bicolor* [L.] Moench.; and soybeans, *Glycine max* L.) and insecticide treated or untreated. In the crop comparison test, 16 rows (20 m long) of corn, sorghum, or soybeans were each planted on the same day in June plantings of replicated plow-tillage or no-tillage plots. Chlorpyrifos was applied at a rate of 0.56 kg [AI]/ha at 10 day intervals for 3 applications, beginning in the 3-leaf stage of development for corn and sorghum, and for 1 application in the V6 stage of soybeans. The chlorpyrifos treatments were 4 row plots x 8 m long and were paired with untreated plots in each of the corn, sorghum, and soybean treatments.

Sampling of fall armyworm infestations was done by examining 5 consecutive plants for egg masses at 3.3 m intervals, covering a field or plot uniformly. At least 500 plants were examined in each experiment. Damage was assessed on the plants when they were examined for egg masses by making a visual estimate of the degree of injury based on

a scale of 0-7. Plants received a 0 rating when no injury was present; 1 was slight (< 10%) leaf damage with no feeding in the whorl as evidenced by the lack of gummy excrement; 2 was moderate (10-20%) leaf damage and no whorl feeding; 3 was heavy (> 20%) leaf damage and no whorl feeding; 4 was < 20% leaf damage and light whorl damage with a slight amount of excrement; 5 was 20-40% leaf damage with a moderate amount of excrement in the whorl; 6 was severe leaf feeding (> 40%) with a large amount of excrement in the whorl; and 7 was plants that had leaves with only midribs remaining and buds destroyed (plant was virtually destroyed).

One or more pheromone traps baited with (Z)-9-dodecen-1-ol acetate were placed in the test fields to monitor fall armyworm adult seasonality patterns. Information on adult flights into fields was used in timing planting operations and insecticide applications in the tests.

The data were analyzed using analysis of variance (SAS Institute 1985) with procedures appropriate for a specified experimental design. Duncan's new multiple range test (Duncan 1955) was used to separate means.

Results and Discussion

Table 1 shows results from 3 tests with no significant difference between plow-tillage and no-tillage in % egg masses (except test 3) or foliar damage by the fall armyworm. These results are representative of general observations in many experiments in corn over several years (1980-1988) of fall armyworm infestations in fields with plants in the 6-leaf stage (25-30 days after planting) or older in comparisons of plow-tillage and no-tillage systems.

On several occasions, it was observed that damage to 2- and 3-leaf stage plants (10-15 days after planting) was greatly reduced in no-tillage as compared with plow-tillage, especially when the no-tillage fields had a heavy mulch from previous crops. Figure 1 shows results from a test using corn planted on July 29 following harvest of rye. A heavy rye mulch was present on the soil surface in the no-tillage plots. Corn germination and development in the no-tillage plots was similar to that observed in plow-tillage. The corn seedlings were shorter than the mulch height up to the early 3-leaf stage. Oviposition and damage were significantly less ($P < 0.05$) in no-tillage plots as compared with plow-tillage. Leaves were first observed above the mulch in the late 3-leaf stage 16 days after planting. This coincided with greater oviposition and, thus, at 20 days the number of egg masses on plants was similar in the 2 tillage systems. Damage remained significantly higher in the plow-tillage plots than in no-tillage. This trend also was evident after 25 days, but the differences were not significant. The number of egg masses that were sampled at 32 days dropped substantially and may reflect sampling error due to diffi-

TABLE 1. Comparison of fall armyworm infestations in no-tillage and plow-tillage corn.

	Till		No-Till	
Test[1]	% Egg Masses	Damage Rating	% Egg Masses	Damage Rating
1 (20 da)	0.8	3.8	0.3	3.7
2 (30 da)	5.7	4.9	6.8	4.0
3 (40 da)	3.0[2]	3.7	0.5	4.0

[1]Tests 1 and 3 were conducted near Griffin and test 2 near Athens GA. A minimum of 100 plants were examined in each plot at a specified number of (days) after planting.

[2]Significantly different from plow tillage in analysis of variance ($P < 0.05$).

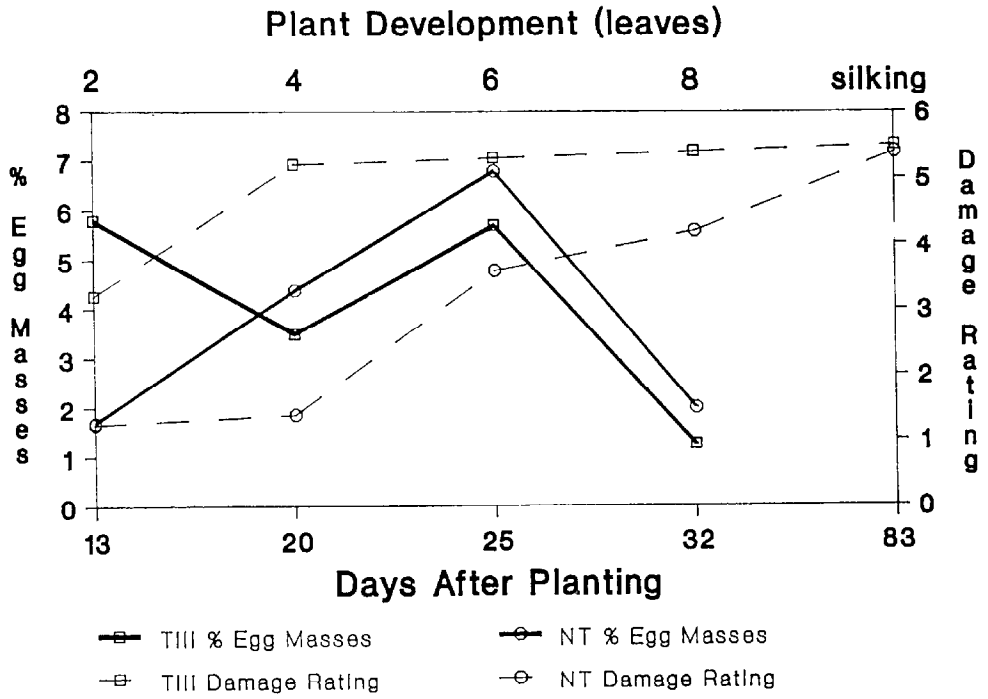

Fig. 1. Seasonal comparison of fall armyworm infestations in no-tillage and plow-tillage corn as expressed by sampling of unhatched egg masses on leaves and by visual estimates of leaf and whorl damage on a scale of increasing severity of 0-7. Significant ($P < 0.05$) differences occurred between tillage systems in egg masses and damage on day 13 and in damage on day 20 after planting.

culty in finding egg masses on the heavily damaged leaves of the late 8-leaf stage plants. Injury was not significantly different in the 2 tillage systems at 32 days, or when the plants initiated silking 83 days after planting. In this test, the yield was significantly ($P < 0.05$) higher in the no-tillage (5033.0 kg grain/ha) treatment as compared with plow-tillage (2597.7 hg/ha).

In another test in which corn, sorghum, and soybeans were compared, there was no significant difference in either fall armyworm damage or yield between the 2 tillage systems in corn and sorghum (Table 2). No infestation occurred in any of the soybean treatments. Significantly ($P < 0.05$) less damage occurred in the noninsecticide-treated sorghum as compared with corn. Chlorpyrifos sprays provided significant ($P < 0.05$) control of infestations in only the plow-tillage treatments of corn, but significant differences in yield occurred between insecticide and nontreated plots in both tillage systems of corn and sorghum.

In conclusion, these data show that infestations of the fall armyworm may be reduced in no-tillage systems under certain circumstances. Infestations on recently germinated plants are reduced during the short period of 5-10 days that seedlings remain below the mulch canopy of certain no-tillage systems. Less oviposition occurs on plants in these situations and may be due to an inability of moths to locate the crop within the mulch. When plants grow above the mulch, oviposition quickly becomes similar to that observed in plow-tillage systems. The ultimate defoliation damage in later crop developmental stages is similar in no-tillage and plow-tillage systems. The lag in the development of fall armyworm infestations in no-tillage may have pest management value by reducing the need for 1 or more insecticide applications to protect young seedlings during the critical post-germination stages of plant establishment and growth.

TABLE 2. FALL ARMYWORM DAMAGE IN CORN, SORGHUM, AND SOYBEANS PLANTED IN NO-TILLAGE AND PLOW-TILLAGE SYSTEMS WITH OR WITHOUT CHLORPYRIFOS (0.56 KG [AI]/HA) TREATMENT.

	Corn			
	Till		No-Till	
	Treated[1]	Untreated	Treated	Untreated
Damage Rating	1.3a	4.2b	2.0a	3.9a
Yield kg/ha x 100	73.2a	22.6b	68.0a	34.8c
	Sorghum			
	Till		No-Till	
	Treated	Untreated	Treated	Untreated
Damage Rating	1.3a	2.1a	1.6a	2.1a
Yield kg/ha x 100	22.6a	11.5b	19.2a	13.4b
	Soybean			
	Till		No-Till	
	Treated	Untreated	Treated	Untreated
Damage Rating	0a	0a	0a	0a
Yield kg/ha x 100	0.6a	0.6a	0.7a	0.5a

[1]Damage rating 60 days after planting was significantly different between crops, but not between tillage. Duncan's multiple range analysis ($P < 0.05$) values are for tillage and insecticide treatments within a crop. Damage and yield analyses are separate.

In comparisons of corn, sorghum, and soybeans, it is apparent that soybeans are least susceptible. Soybeans would be preferred over the other crops in high hazard situations for fall armyworm infestations, such as certain double cropping systems that have later than normal planting dates. In situations where insecticides are required to suppress fall armyworm infestations, data indicate that chemical control operations utilized in plow-tillage systems are applicable to no-tillage.

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