INFLUENCE OF FOUR CORN CULTIVARS ON FALl ARMYWORM (LEPIDOPTERA: NOCTUIDAE) ESTABLISHMENT AND PARASITIZATION

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ABSTRACT

Establishment of fall armyworm (FAW), Spodoptera frugiperda (J. E. Smith), larvae was significantly lower on resistant ‘Antigua 2D-118’ and ‘Pioneer X304C’ than upon susceptible ‘Cacahuacinte X’s’ and ‘Pioneer 3369A’ corn lines. There was a significant effect between years and rates of artificial infestation on FAW larval establishment and parasitization. A density-dependent response of parasitoids was indicated in 1982 but not in 1983 when fewer larvae became established in the 2nd planting, possibly due to a combination of rainfall and advanced plant development. Greater numbers of larvae established when plants were artificially infested with 10 larvae per plant compared with 20 or 40 larvae. Although ‘Pioneer X304C’ and ‘Antigua 2D-118’ had significantly fewer larvae in post-infection counts, rates of parasitization were higher than for larvae observed on susceptible corn lines. A probable cause was that FAW larvae on corn lines with nonpreference-type resistance exhibited more movement and were more exposed to parasitoids. Campoletis sp. was the primary parasitoid species involved in both years.

RESUMEN

El establecimiento de larvas del gusano cogollero, Spodoptera frugiperda (J. E. Smith), fue significativamente menor en las variedades resistentes de maíz ‘Antigua 2D-118’ y ‘Pioneer X 304C’ que en las susceptibles ‘Cacahuacinte X’s’ y ‘Pioneer 3369A’. Hubo un efecto significativo entre los años y los grados de infestación artificial en el establecimiento y parasitismo de larvas del gusano cogollero. Se indicó en 1982 pero no en 1983, una reacción dependiente de la densidad de parasitoides cuando menos larvas se establecieron en la 2da. siembra, posiblemente debido a una combinación de precipitación y el desarrollo avanzado de las plantas. Un número mayor de larvas se establecieron cuando las plantas se infestaron artificialmente con 10 larvas por planta, comparadas con 20 ó 40 larvas. Aunque ‘Pioneer X 304C’ y ‘Antigua 2D-118’ tuvieron significativamente menos larvas en los controles después de infestadas, los grados de parasitismo fueron más altos que las larvas observadas en variedades susceptibles de maíz. Una probable causa fue que larvas del gusano cogollero con el tipo de resistencia de no-prefeencia, tuvo más movimiento y estuvieron más expuestas a parasitoides. Campoletis sp., fue la primera especie de parasitoides en ambas años.

The development of resistant varieties has been considered as an ideal method of controlling insects (Luginbill 1969). Efforts to decrease losses in corn due to fall armyworm (FAW), Spodoptera frugiperda (J. E. Smith), through the development of resistant varieties have traditionally emphasized techniques designed to screen genetic lines for their nonpreference, antibiosis, and/or tolerant characteristics. There is an increased need to determine the compatibility of plant resistance and biological control programs. Bergman and Tingley (1979) provide an excellent review of the various types of interactions that can occur between host plants, insect pests, and their natural
enemies. “Non-preference” resistance to FAW was identified in ‘Antigua 2D-118’ when larvae placed on these varieties exhibited greater movement and less feeding on ‘Antigua 2D-118’ compared to susceptible corn lines such as ‘Cacahuacintle X’s’ (Wiseman et al. 1980b, 1981, 1983). Wiseman (1985) suggested that nonpreference for ‘Antigua 2D-118’ may alter FAW feeding behavior and development sufficiently to increase vulnerability to natural enemies. However, little information is available concerning the influence of resistant corn varieties upon beneficial insect populations. Studies involving European corn borer, Ostrinia nubilalis (Hubner), and a tachinid parasitoid, Lydella grisescens Robineau-Desnoy, indicated that corn variety, not host presence or density, influenced the rate of parasitization (Franklin and Holdaway 1966). In other crops, glabrous cotton phenotypes are less attractive for Heliothis zea (Boddie) oviposition than are hirsute phenotypes; however, rates of egg parasitization by Trichogramma pretiosum (Riley) were greater in glabrous types (Treacy et al. 1985). Conversely, resistant host plants may be indirectly detrimental to parasitoids by modifying the rate of reproduction and nutrition of developing host larvae (Powell and Lambert 1984, Orr and Boethel 1985).

Because there is a need to better define the relationships between corn genotypes and beneficial insects, studies were conducted at Tifton, GA in 1982 and 1983 to determine the influence of resistant and susceptible corn lines on the rate of parasitization of FAW larvae.

**Materials and Methods**

Wiseman et al. (1980b) and Gross et al. (1982) reported ‘Cacahuacintle X’s’ and ‘Pioneer 3369A’ as susceptible while ‘Antigua 2D-118’ and ‘Pioneer X304C’ were resistant to FAW establishment. Test plots were planted 6 and 11 May 1982, and 2 and 16 May 1983. Each year, plantings were arranged in a split-plot design consisting of 6.1 m single-row plots with 6 replications per infestation level. Plots were bordered by rows of the Kalb 1214’ hybrid corn and all plantings were maintained using standard agronomic practices. At the 8-10 leaf stage of development, all plants in each plot were artificially infested with FAW larvae from a laboratory colony (Perkins 1979) using the modified bezooka method (Wiseman et al. 1980a). Neonates were dispensed in a corn cob grits mixture at the rate of 10 or 20 (1st planting) and at 20 or 40 per plant (2nd planting). At 3-6 days post infestation, 5 plants per plot were randomly selected, excised, and transferred in plastic bags to the laboratory. The number of larvae per plant was recorded and transferred individually to labeled cups containing an artificial diet (Perkins 1979). Parasitoids emerging from FAW were recorded and identified based on reference collections previously identified by the USDA Systematic Entomology Laboratory, Beltsville, MD. Data were analyzed by ANOVA and percentage parasitization values were changed via arcsin transformation prior to analyses. Duncan’s multiple range test was used to separate means (SAS Institute 1982).

**Results and Discussion**

Results showed that there was no significant three-way interaction among years, corn lines, and infestation levels for rates of larval establishment and parasitization in either year. However, there was a significant interaction \((P < 0.01)\) between infestation level and year for rates of larval establishment and parasitization (Table 1). In 1982, the rate of larval establishment was greater when 10 larvae per plant were applied than in rates of 20 or 40 larvae per plant. In 1983, establishment was similar between 10 and
<table>
<thead>
<tr>
<th>Infestation rate (larvae/plant)</th>
<th>% no. larvae established/plant</th>
<th>% % parasitized larvae</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1982</td>
<td>1983</td>
</tr>
<tr>
<td>10</td>
<td>3.8a</td>
<td>2.5a</td>
</tr>
<tr>
<td>20</td>
<td>2.5b</td>
<td>30.3a</td>
</tr>
<tr>
<td>40</td>
<td>2.3a</td>
<td>22.4a</td>
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Means within a column followed by the same letter are not significantly different at $P = 0.05$.

20 larvae per plant and both were significantly greater than the rate of 40 larvae per plant. Rates of parasitization were significantly lower when 10 larvae per plant were applied than at 20 or 40 larvae per plant. In 1983, no differences in percentage parasitization were shown among infestation rates. A density-dependent response of parasitoids was indicated during 1982 but not in 1983. Initial infestations during the second planting failed, possibly due to 11.4 mm of rainfall on 22 June after larvae were applied. Larvae were reinfeasted on 29 June, and again 5 mm of rainfall occurred following the application of larvae. Gross et al. (1982) reported increased antibiosis to FAW larvae in pre-tassel stage 'Pioneer X304C' corn. In our study, development had advanced to the pre-tassel stage which, when coupled with rainfall, resulted in fewer larvae establishing per plant.

Establishment and parasitization of FAW larvae on susceptible and resistant corn lines are shown in Table 2. Significant differences in larval establishment were found among all corn lines, with the lowest number of larvae found on 'Pioneer X304C'. Significantly more larvae were observed on both of the susceptible corn lines than were observed on either of the resistant lines.

While fewer larvae became established on 'Pioneer X304C', rates of parasitization were significantly higher on this corn line than for either 'Cacahuaentle X's' or 'Pioneer 3369A'. Although significant differences among corn lines and larval establishment were shown, the relationships between parasitoid response and corn line were less apparent. Indeed, while the rate of parasitization observed on 'Antigua 2D-118' was ca. 1.5 times higher than on susceptible lines, there were no differences between it and other varieties.

Campoletis sp. was the primary parasitoid species involved each year and accounted for 45.8 and 90.8% of the total parasitization in 1982 and 1983, respectively. C. sonorensis (det. by H. K. Towne) is one of the most important FAW parasitoids in corn grown in the Gulf Coast states (Pair et al. 1986). In 1982, Rogas laphygmae Viereck were recovered from 40% of the parasitized larvae. Other species recovered during the study were Cotesia marginiventris (Cresson), Meteorus autographae Muesebeck, Ophion flavus Brulle, Archytas marmoratus (Townsend), and Lespesia archippivoraa (Riley). Because Campoletis sp. and R. laphygmae were the primary species involved in this study, it is difficult to determine whether other species respond in a similar manner dependent upon their searching behavior and their mode of oviposition.
<table>
<thead>
<tr>
<th>Corn line</th>
<th>Ŕ no. larvae established/plant</th>
<th>Ŕ % parasitized larvae</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Cacahuacintle X's'</td>
<td>3.4a</td>
<td>16.2b</td>
</tr>
<tr>
<td>'Pioneer 3869A'</td>
<td>2.8b</td>
<td>15.3b</td>
</tr>
<tr>
<td>'Antigua 2D-118'</td>
<td>2.2c</td>
<td>24.7ab</td>
</tr>
<tr>
<td>'Pioneer X-304C'</td>
<td>1.7d</td>
<td>27.4a</td>
</tr>
</tbody>
</table>

*Means within a column followed by the same letter are not significantly different at F = 0.05.

This study indicates that corn lines exhibiting nonpreference resistance characteristics may influence both the establishment of FAW and the response of parasitoids to their hosts. Apparently these effects are the result of greater exposure to parasitoids seeking hosts due to increased larval movement on non-preferred corn lines.

The impact of resistant corn lines upon the nutritional requirements for development of parasitoids was not addressed here; however, experiments conducted by Isenhour and Wiseman (unpublished data) indicate that FAW fed 'Antigua 2D-118' and 'Pioneer X304C' do not affect the development of *C. sonorensis*. These data suggest that plant resistance programs impact biological control mechanisms and that a combination of the two techniques could result in more efficient management of the pest insect.

**REFERENCES CITED**


CHEMICAL CONTROL OF THE FALL ARMYWORM (LEPIDOPTERA: NOCTUIDAE): AN UPDATE

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ABSTRACT

Fall armyworm (FAW), Spodoptera frugiperda (J. E. Smith), populations in the southeastern United States are resistant to carbaryl, methyl parathion, trichlorfon, and diazinon, whereas FAW in the mid-south and west of the Mississippi River do not appear to have a high level of resistance to these insecticides. Methomyl has been effective in all areas, but the level of susceptibility in Florida may be declining. The efficacy of insecticide treatments in some crops appears to be related to plant coverage by spray application. Carbaryl, methyl parathion, and permethrin spray applications are reported to be more effective on FAW larvae feeding on seed heads than in the whorls. Chlorpyrifos, sulprofos, and thiodicarb are relatively new materials that have proved to be effective against FAW in many areas, while the synthetic pyrethroids have provided erratic control of FAW larvae. Combinations of pyrethroids and chlorpyrifos at rates lower than recommended give effective FAW control. Resistance or moderate to low levels of resistance to carbaryl, phoxim, methyl parathion, trichlorfon, and/or methomyl have been reported in some areas of Central and South America.

Spray applications are most effective when high volumes of aqueous carrier are used with either ground, chemigation or air equipment. Ground equipment with the higher water rates provides higher levels of insect control. Insecticide granules applied in the whorl are effective and may provide an increased level of control of FAW larvae compared to some recommended aqueous spray applications.

Resumen

En el sudeste de los Estados Unidos, poblaciones del gusano cogollo, Spodoptera frugiperda (J. E. Smith), son resistentes al carbaryl, metilo de parathion, trichlorfon, y diazinon, mientras que gusanos cogollos en el medio-sur y oeste del Rio Mississippi no aparentan tener un alto nivel de resistencia a estos insecticidas. Methomyl ha sido efectivo en todas las áreas, pero el nivel de susceptibilidad pudiera estar declinando en