Yield Impact of Larval Infestations of the Fall Armyworm (Lepidoptera: Noctuidae) to Midwhorl Growth Stage of Corn

I. CRUZ2 AND F. T. TURPIN
Department of Entomology, Purdue University, West Lafayette, Indiana 47907

J. Econ. Entomol. 76: 1052–1054 (1983)

ABSTRACT Egg masses of fall armyworm, Spodoptera frugiperda (J. E. Smith), were artificially placed on corn at the midwhorl growth stage. Levels of infestation tested included egg masses on 5, 10, 15, 20, and 100% of the plants. Populations were assessed by leaf damage ratings. Yield parameters of grain weight, ear length, kernel number, ear damage, number of damaged kernels, and weight of 100 kernels were measured. Significant yield losses of 17% were sustained when 20 or 100% of the plants received egg masses. The relationship of leaf damage ratings and yield was linear and inverse. Yield losses were directly related to reduction in kernel numbers on ears from infested plants.

Larval feeding on foliage and ear tips and in the whorl of corn, Zea mays L., by fall armyworm (FAW), Spodoptera frugiperda (J. E. Smith), was reported to cause annual losses estimated at $300 to $500 million in the United States (Mitchell 1979). Although the biology and control of FAW is well documented (Hinds and Dew 1915, Luginbill 1928, Lincoln and Isley 1945, Roberts 1965, Bowman and Young 1969, Hamm and Young 1971, Janes 1975), little information about the relationship between levels of infestation and corn yield is available. Control decisions for FAW must be based on economic thresholds. We studied the relationship between midwhorl infestations of FAW and grain yield on field corn.

Materials and Methods

The hybrid cultivar ‘DeKalb XL-45’ was planted at Lafayette, Ind., in rows, 76 cm apart, in 1978 and 1979 in a soil bed prepared and fertilized to conform with standard cropping practice. Seeding rate was ca. 51,600 kernels per ha. A herbicide mixture of butylate (0.82 liters of Al/ha) and atrazine (0.33 liters of Al/ha) was broadcast preplant and incorporated for weed control. An insecticide (chlorpyrifos at 0.11 g of Al/m of row) was applied as a 15.2-cm band over the row at planting to control corn rootworm, Diabrotica sp. larvae. Planting dates were 5 June 1978 and 24 May 1979.

FAW egg masses were obtained from a laboratory culture maintained by procedures described by Burton (1967), but a diet of black cutworm, Agrotis ipsilon Hufnagel, (Reese et al. 1972) was used for feeding the larvae. Around 50 eggs per mass were pinned through the midrib on the underside of the largest leaf of a test plant. Plants were 60 to 70 cm tall, with 8 to 10 exposed leaves at time of infestation.

The experiment was a randomized complete block design with four replications. Plots were enclosed by a 30-cm-high barrier of 8-mm clear plastic suspended from wire and buried at the base in soil. The physical barrier minimized movement of FAW larvae between plots which were 3 by 3 m (four rows) in 1978 and 3 by 2.3 m (three rows) in 1979. Each row contained 13 or 14 plants. Randomly selected plants received one egg mass per plant. Treatment levels of the plants with egg masses in 1978 were 0, 5, 10, 20, and 100%. In 1979, a 15% level was substituted for the 5% level. Data were collected from 20 randomly selected plants within the center two rows in 1978 and the entire plot in 1979.

After 22 days of infestation, leaf feeding was rated by the method of Carvalho (1970) as: (1) no damage, (2) pinhole feeding damage, (3) shothole leaf damage, (4) portion of leaf destroyed and some whorl damage, and (5) entire whorl destroyed. Ears were hand harvested when mature, and damage was rated by the method of Wildstrom (1967), but adjusted for feeding on parts of the ear other than the top. Data on ear length, kernel weight and number, percentage of damaged kernels, and moisture content were also collected.

Analysis of variance was performed on data sets from both years of the study. Equality of variance was tested with the Burr-Foster Q test and data normality with the Shapiro and Wilk W test (Anderson and McLean 1974). Percentage data were transformed by arc sin √x to stabilize variance. Mean separation was achieved by using the student-Newman-Keuls test. The 5% level of significance was used. Regression equations were fit to all data sets.

Results and Discussion

Leaf Damage

The percentage of plants with leaf feeding (Table 1) indicated the uniformity of infestation in the plots. At all infestation levels, significantly higher percentages of leaf feeding occurred than in control plots. In 1979, 12.5% of the plants in the control plots showed leaf feeding by FAW larvae. This and the overall higher percentage of plants showing leaf feeding in 1979 rather than in 1978 probably reflected a low-level natural infestation of FAW in 1979.

In 1978 and 1979, no significant difference in percentage of plants with leaf feeding existed between 100% and 20% of the plants infested with egg masses. In addition, we found that the 10 and 15% levels in 1979

---

1 Contribution from the Dept. of Entomology, Journal Paper No. 9216, Purdue Univ. Agric. Exp. Stn. Received for publication 6 January 1983; accepted 11 May 1983.
2 Present address: Centro Nacional de Pesquisa de Milho e Sorgo - EMBRAPA, Caixa Postal, 151-35700-SETE LAGOAS - BRASIL.

1052
Table 1. Effect of various levels of fall armyworm infestation on grain weight, ear length, kernel number, and leaf feeding damage to corn

<table>
<thead>
<tr>
<th>Year</th>
<th>Plants (%) with:</th>
<th>Leaf feeding*</th>
<th>Grain wt (g/ear)</th>
<th>Ear length (cm)</th>
<th>Kernel no.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Egg masses</td>
<td>Leaf feeding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>97.5a</td>
<td>3.9a</td>
<td>149a</td>
<td>16.4a</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>91.3a</td>
<td>3.3b</td>
<td>143a</td>
<td>16.6a</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>31.3b</td>
<td>1.5c</td>
<td>168b</td>
<td>17.2b</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>23.8b</td>
<td>1.3c</td>
<td>173b</td>
<td>17.2b</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0.0c</td>
<td>1.0c</td>
<td>176b</td>
<td>17.6c</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1979</td>
<td>100</td>
<td>100.0a</td>
<td>4.2a</td>
<td>179a</td>
<td>17.1a</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>100.0a</td>
<td>3.3b</td>
<td>186a</td>
<td>18.3b</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>65.0a</td>
<td>2.2c</td>
<td>203b</td>
<td>18.8b</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>70.0a</td>
<td>1.9d</td>
<td>209bc</td>
<td>18.8b</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>12.5b</td>
<td>1.2d</td>
<td>220c</td>
<td>18.5b</td>
</tr>
</tbody>
</table>

*Means within columns, by year, followed by same letter are not significantly different (P = 0.05), by Student Newman-Keuls sequential range test.

Factors influencing grain weight included ear length and kernel number. The lowest kernel number averages were obtained from plots with egg masses on 100 and 20% of the plants (Table 1). These averages were not significantly different, but both differed significantly from all other treatments in both years. The reduction in the number of kernels reached 13.9 and 13.6% for plots with egg masses on 100 and 20% of the plants.

Leaf damage rating was a better indicator of the number of kernels than number of egg masses applied. In fact, a significant linear relationship existed between leaf damage rating and grain weight (Fig. 1). The addition of a quadratic term improved the fit of the regression equation between kernel number and number of egg masses at 20% infestation level (20% infestation).

**Grain Yield**

In 1978 and 1979, egg masses on 100 and 20% of the plants produced significantly lower yields than other infestation levels (Table 1). However, the difference in yields between these infestation levels was not significant. On the average, yield reductions compared with the uninfested control were 17.1, 17.0, 7.7, 4.5, and 1.7% for 100, 20, 15, 10, and 5% of the plants infested with egg masses, respectively. A linear regression provided a significant fit to the data. However, a second-degree polynomial provided a better fit between grain weight and percentage of plants with egg masses (1978: y = 180.3 - 200x + 168.7x², R² = 0.91; 1979: y = 228.8 = 182.4x + 138.5x², R² = 0.93, where y = grain wt (g per plant) and x = percentage of plants with egg masses (in decimals)).

![Fig. 1. Leaf damage rating and grain weight relationship of corn plants infested at the midwhorl growth stage with fall armyworm.](image-url)
masses, although both equations were significant. The second-degree polynomial equations were: 1978—y = 595 - 361x + 298x^2, R^2 = 0.91; 1979—y = 633 - 533x + 405x^2, R^2 = 0.81, where y = number of kernels and x = number of egg masses applied. The weight of grain decreased linearly as the number of kernels decreased. The equations for both years were: 1978—y = -127.04 + 0.52x, R^2 = 0.99; 1979—y = 23.98 + 0.31x, R^2 = 0.96, where y = grain weight and x = number kernels per ear.

In both study years, the highest FAW infestation resulted in the shortest ears in the test (Table 1). In 1978 the highest level of infestation (100% plants with egg masses) did not produce significantly shorter ears than the next lower level (20% plants with egg masses) but was significantly different than all other levels. In 1979 the highest level of infestation produced a significantly shorter ear than all other treatments, which were not different from each other. The regression analyses showed that a second-order equation in 1978 and a linear equation in 1979 best described the relationship between length of ears and number of egg masses applied (1978: y = 17.6 - 5.6x + 4.4x^2, R^2 = 0.97; 1979: y = 17.5 - 4.7x, R^2 = 0.94, where y = ear length (cm) and x = percentage of plants with egg masses [in decimals]).

The relationship between the leaf damage rating and the resulting number of kernels was linear in both years. The equations were: 1978—y = 607.3 - 21.3x, R^2 = 0.94; 1979—y = 675.1 = 43.0x, R^2 = 0.93, where y = kernels per ear and x = leaf damage rating. These results indicate the validity of leaf damage for measuring potential yield reduction for corn plants infested with FAW at the midwhorl stage.

Ear damage, number of damaged kernels, and weight of 100 kernels were not related to the different infestation levels of FAW applied at the midwhorl growth stage of corn.

REFERENCES CITED


