Single-larva infestations with **Diatraea saccharalis** (F)[1/] in two tropical maize populations in Mexico[*2/]

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COMPENDIO

Dos variedades tropicales de maíz fueron infestadas, artificialmente, con una o dos larvas de Diatraea saccharalis *(F) por planta, con el objeto de determinar el efecto sobre el rendimiento y la interacción con el largo del túnel, la posición relativa, los sólidos solubles en el tallo y el tallo infectado. Se demostró que el efecto sobre el rendimiento no es consistente. El largo del tunel fue afectado más por el medio ambiente que por la respuesta varietal, la posición del entrenudo, o la concentración de sólidos solubles. El taladrador intervino en la diseminación de la podredumbre del tallo, entre los entrenudos, y la interacción enfermedad-insecto fue mayor en los entrenudos basales que en los apicales.*

Introduction

THE sugarcane borer (SCB), *(Diatraea saccharalis* (F.), is an important insect pest of maize in Latin America and the southern United States. Damage includes leaf feeding, deadheart, lodging, broken shanks and ear damage (6). Yield loss in Louisiana was attributed to increased barrenness, reduced ear size, reduced grain size, and interference with mechanical harvesting (5). Because of the lack of information on relationship between the SCB and tropical maize, studies were initiated to: 1) examine the effect of single-larva SCB boring on yield in tropical maize; 2) examine the relationships between tunnel length or position and yield; 3) determine if there is a correlation between total soluble solids in the stalk and the amount of tunneling; and 4) determine if the sugarcane borer is involved in stalk rot in tropical maize in Mexico.

Materials and methods

Experiment I was conducted from 23 August, 1975 to 6 January, 1976; Experiment II from 24 November, 1975 to 20 April, 1976; Experiment III from 5 May, 1976 to 10 September, 1976; and Experiment IV from 26 May, 1976 to 14 September, 1976. Experiments I-III were planted at the International Maize and Wheat Improvement Center's (CIMMYT) subtropical field station located at Tlaltizapan, Morelos, México at 940 m above sea level. Experiment IV was planted at the lowland station at Poza Rica, Veracruz at 60 m above sea level.

Two of CIMMYT'S open-pollinated maize varities were used: 'Tuxpeño-1', a late- maturing white dent and 'Antigua X República Dominicana', a yellow dent of intermediate maturity. Only 'Tuxpeño-1' was used in Experiment IV. Four replications of randomized complete blocks of three 5-meter row plots in Experiments II, III, and IV and six 5-meter row plots in Experiment I were planted at a spacing of 75 cm between rows and 21 cm between hills. Ten plants plot in Experiment I and 20 plants/plot in Experiments II, III, and IV were observed.

Spodoptera frugiperda (J.E. Smith) was controlled by applications of carbofuran 2G (1 kg a.i./ha) with the seed and by foliar applications of carbaryl 80WP and parathion 46EC (2.4 kg a.i. + 0.5 kg a.i. in 400 LH_2O/ha) until the plants were about 30 days old.

1/ Lepidoptera, Pyralidae.

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2/ Work conducted while the senior author was a predoctoral fellow at the International Maize and Wheat Improvement Center, El Batan, Mexico.
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Natural populations of *Diatraea* spp., negligible in Tlaltizapan but somewhat higher in Poza Rica were not controlled.

Infestation treatments were:

1. Uninfested check.
2. Larva placed in 2nd internode visible above the ground.
3. Mock infestation
4. Larva placed in the internode subtending the primary ear.
5. Mock infestation as in 4
6. Combination of 2 and 4.
7. Combination of 3 and 5

Treatments 1, 2 and 4 were used in Experiments I, 1-5 in Experiments II, and 1-7 in Experiments III and IV. Infestations were made with similar sized 3rd or 4th instar larvae, the same age larvae being used within a plot. Two to 3 mm entrance holes were made with a spike in Experiment I and with a 3 mm cork borer in the others. After the larva was placed within the stalk, the entrance hole was taped to discourage larvae from leaving and to prevent other insects from entering.

Soluble solid levels, a general measure of sugar concentration, were determined with a hand-held refractometer. In Experiment I samples were taken from corresponding internodes in unifested plants within the plots, while in the rest the core removed while preparing the entrance holes was used.

Dry grain yield and tunnel length in each infested internode were recorded at harvest. Intensity of stalk rot in the two internodes studied was rated (1-5 with 1 being least and 5 most damaged) in Experiments III and IV at harvest.

Results and discussion

Single-larva boring effect an yield.

There were no significant differences among the yields, nor were there any consistent patterns in the relationships of yield in infested plots to the unifested or mock-infested treatment yields (Table 1). In contrast, Chiang (3) in Minnesota found that infestation with the European corn borer, *Ostrinia nubilalis* (Hubner) consistently reduced yield of two temperate hybrids by 3.0 to 22.5 per cent per borer. Chiang infested with egg masses, affording a longer feeding period. Larval survival per tunnel was approximately 80 per cent, similar to final survival in the Minnesota experiments.

The threshold for consistent yield loss in these maize populations to SCB was greater than 1.7 borers per plant, the infestation level attained in treatment 6. The tropical maize populations tested were more tolerant of SCB tunneling than were the Minnesota hybrids of European corn borer feeding. This difference could be due to plant or insect characteristics or experimental methods or a combination.

Tunnel length and position

Tunnel length was not affected by internode or variety, ranging from 3.7 cm in 'Tuxpeño-1' in Experiment II to 5.3 in 'Tuxpeño-1' in Experiment IV. Tunnel length was affected by environment as simple

Table 1.—Dry grain yields[1/] of tropical maize infested with sugarcane borer. Poza Rica and Tlaltizapan, México 1975-1976.

Treatment	Experiment[2/] I		II		III		IV		Mean	
	TX	ARD	TX	ARD	TX	ARD	TX	ARD	TX	ARD
1	100 0	100.0	100 0	100 0	100 0	100.0	100.0	—	100.0	100.0
2	115.7	109.6	113.1	95.8	75 7	99.1	106 2	—	102.7	101.6
3	—	—	96 3	90.1	83.5	111.3	115 8	—	98.3	100 7
4	116.7	87.1	107.6	93 8	92 8	109.4	113 5	—	107.6	96.8
5	—	—	109.3	80 7	96.1	103.4	91.7	—	99.0	92.0
6	—	—	—	—	95 2	93.5	101 7	—	98.4	93.5
7	—	—	—	—	86 8	105.3	93.8	—	90 3	105.3

1/ Yields expressed as percentage of uninfested check.

2/ Experiments I, II, III conducted in Tlaltizapan, IV in Poza Tica; TX=Tuxpeño-1, ARD=Antigua x Republica Dominicana.

Table 2.—Correlations of refractometer readings with sugarcane borer tunnel lengths. Poza Rica and Tlaltizapan, México. 1976.

Experiment[1]/	Material	Treatment[2]/	Observations[3]/	Coeficient Correlation
II	Antigua X República Dominicana	2	68	-0.140
		4	60	-0.183
	Tuxpeño-1	2	62	0.048
		4	47	-0.014
III	Antigua X República Dominicana	2	65	-0.119
		4	69	0.141
		6-2nd	70	-0.294*
		6-ear	67	0.113
IV	Tuxpeño-1	2	69	-0.178
		4	68	-0.292*
		6-2nd	67	0.062
		6-ear	70	-0.093
	Tuxpeño-1	2	63	-0.111
		4	63	-0.099
		6-2nd	70	-0.068
		6-ear	63	-0.026

1/ Experiment I omitted as readings were taken from adjacent uninfested plants and therefore relatively unreliable, II and III in Tlaltizapan, IV IV in Poza Rica.

2/ 2nd indicates second internode as in treatment 2, while ear indicates internode subtending ear as in Treatment 4

3/ Plants without tunneling not included.

*/ Significant at 5% level.

regression of mean daily temperature for the month of infestation on tunnel length averaged over varieties gave a correlation coefficient of -0.980 (significant at $p = 0.01$). Temperatures ranged from a daily mean of 19°C in Experiment II to 26.5°C in Experiment IV. Higher temperatures would advance pupation and reduce feeding time and perhaps tunnel length.

Simple regression of mean tunnel length on yield of dry grain produced correlation coefficients ranging from 0.004 in Experiment III to 0.075 in Experiment II, indicating little relationship between the two variables. In contrast to the findings of Chiang (3), there was no apparent relationship between tunnel position and yield reduction.

Table 3.—Correlations of stalk rot ratings with sugarcane borer tunnel lengths. Poza Rica and Tlaltizapan, México. 1976.

Experiment[1]/	Material	Treatment[2]/	Number of Observations	Correlation Coeficient
III	Antigua X República Dominicana	2	80	0.538 **
		4	80	0.205
		6-2nd	80	0.543 **
		6-ear	80	0.433 **
	Tuxpeño-1	2	80	0.501 **
		4	80	0.394 **
		6-2nd	80	0.523 **
		6-ear	80	0.627 **
IV	Tuxpeño-1	2	80	0.416 **
		4	80	0.558 **
		6-2nd	80	0.426 **
		6-ear	80	0.475 **

1/ III in Tlaltizapan, IV in Poza Rica

2/ 2nd indicates second internode as in treatment 2, ear indicates internode subtending ear as in treatment 4

** Significant at 1% level

Larval survival, indicated by plants with tunnels at harvest, was not affected by internode or variety. Chiang found higher survival in internodes nearer the ear. Differences in these experiments might have appeared if younger, smaller larvae, often more susceptible to resistance mechanisms, had been used

Soluble solids

The correlations of refractometer readings and tunnel length were generally nonsignificant and negative (Table 2). Factors other than soluble solids (sugars) were involved in determining the amounts of tunneling. Sugars were feeding stimulants for *O. nubilalis* (1) and *D. grandiosella* Dyar (4) reared in the laboratory. If higher sugar levels caused more rapid development in addition to increased feeding then negative correlations would be expected between refractometer readings and tunneling.

Table 4.—Stalk rot means[1/] in Poza Rica and Tlaltizapan, México, 1976

Poza Rica		Tlaltizapan	
Treatment		Treatment	Mean
2	4.5 a	2	4.4 a
6	4.1 a	6	3.9 b
5	3.6 b	3	3.8 bc
3	3.5 b	4	3.6 bcd
4	3.4 b	7	3.4 cd
7	3.3 b	5	3.3 d
1	2.0 c	1	1.6 e

1/ Means with the same letter are not significantly (p=0.05), according to Duncan's New Multiple Range Test.

Stalk rot and stalk boring

Tunnel length was strongly correlated with stalk rot ratings in two distinct environments (Table 3). Stalk rot generally extended the length of the tunnel, but no farther. Apparently the SCB was involved with the spread of the disease within the internode. Less clear is whether the borer introduces rot-causing organisms as demonstrated with the European corn borer in Minnesota (3). All treatments had significantly more rot than the check (Table 4), indicating that making the entrance hole was sufficient to introduce the disease. Treatments with the second internode infested had significantly more rot than their respective mock infestations, indicating that an interaction between the SCB and stalk rot occurred in the lower internode which did not occur in the upper. In the United States, stalk rot from artificial innoculation increased in severity from the basal to the apical internodes (2). If this were the case with tropical maize, the borer could be breaking down the resistance of the lower internode.

Conclusions

The tropical maize populations tested were apparently more tolerant to SCB boring than were temperate maize hybrids infested by a similar method with the European corn borer. Tunnel length was more consistently correlated with mean daily temperature than with variety, internode position or concentration of soluble solids at time of infestation. The SCB was apparently involved with the spread of stalk rot within internodes. The disease-insect interaction was greater in the lower internode. Whether or not the SCB introduced rot-causing pathogens into the plant was not clear. The method of infestation was satisfactory for studying some aspects of the relationships between SCB boring and tropical maize.

Summary

Two tropical maize varieties were artificially infested with one or two *Diatraea saccharalis* (F.) larvae per plant to determine effect and interactions among yield, tunnel length and position, soluble solids in the stalk, and stalk rot. No consistent efect on yield was demonstrated. Tunnel length was more affected by environment than by variety, internode position, or concentration of soluble solids. The borer was involved in the stalk rot spread within internodes and the disease-insect interaction was greater in basal than in the apical internodes

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