Transmission of Corn Genotype Attractiveness to Ovipositing European Corn Borer[1] Moths to Hybrid Combinations

RAY T. EVERLY
Department of Entomology
Purdue University, West Lafayette, Indiana 47907

Introduction

Corn genotypes differ in their attractiveness to European corn borer moths, *Ostrinia nubilalis* (Hbn.), as measured by the number of eggs laid on them (1, 4). The ratio of this attractiveness may be as great as 1 to 25. These relative differences hold throughout the attractive period in the life of the corn plants. The factors responsible for differences in attractiveness are independent of those for survival resistance and for tolerance and if transmissible into single-cross combinations, they offer another facet in the biological control of the corn borer through plant resistance.

Data obtained by other observers (5,6,7,8,9) indicated that differences in attractiveness existed in early corn hybrids. However, since little was known of the attractiveness of inbred lines comprising them, it could not be determined to what extent this attractiveness was due to the inbred lines in their pedigrees.

In 1944-1946 studies were conducted at Lafayette, Indiana, to determine the relationship of the attractiveness of single-crosses and the inbred lines comprising them. All single-crosses involving 3 low and 3 high attractive inbred lines were tested.[2]

Methods and Procedures

All-possible single-cross combinations of 3 low and 3 high attractive inbred lines were tested in 15 x 15 Latin squares with 3 single plant hills per plot. Other single-cross tests were five single plant hill plots, planted in completely randomized blocks with 6 replications.

Generally, corn was planted in late April and each hill was immediately covered with commercial wax paper domes to accelerate germination and protect the young plants from early adverse environmental conditions. At the start of oviposition plants were examined every third day and egg masses were marked, counted and number of eggs recorded by plant. At a date near the middle of the egg-laying period, each plant height was measured to the tip of the longest leaf held upright.

Everly *et al* (4) demonstrated that the differences between low and high attractive inbred lines increased in direct proportion with an increase in level of oviposition. To compare these single-crosses from season to season and from experiment to experiment, the number of observed eggs per plant was adjusted for differences in plant height at mid-oviposition by statistical regression methods (3). The adjusted number of eggs per plant was standardized to a mean of 40 eggs per plant, by proportional methods based on the level of oviposition for each year.

---

[1]Lepidoptera: Pyralidae

[2]Although information was gathered between 1944 and 1946, it is applicable to European corn borer research today.

1944 Single-Cross Tests

In 1944, 15 single-crosses comprising combinations of 3 low attractive inbred lines, Illinois A, Illinois R4 and Wisconsin W23, and 3 high attractive inbred lines, USDA CI.540, Iowa L317 and Indiana WF9 were tested. The data on the amount of oviposition and the height of the corn are given in Table 1.

Statistical analysis indicated highly significant differences among the single-crosses, both in respect to height at mid-oviposition and in the number of eggs laid. After adjusting the number of eggs laid per plant for differences in height, highly significant differences still existed among the entries.

The single-cross Ill. A x Wis. W23, which as inbred lines were among the least attractive, received the fewest eggs. It was significantly less attractive than all the others except Wis. W23 x Ind. WF9 and Ill. A x Ind. WF9. The single-cross comprising the 2 high attractive inbred lines Ind. WF9 and Ia. L317 was in the high attractive group receiving the most eggs but did not differ significantly from others in this group.

TABLE 1. *Plant height and eggs laid by European corn borer moths during early summer on single-cross combinations of three low and three high attractive corn inbred lines. 1944. Lafayette, Indiana.*

Single Cross	Ave. Height in inches at 50% Oviposition	Number of eggs laid per plant		
		Observed	Adjusted for Height Differences	Standardized to Mean of 40.0
Low attractive x *Low attractive*				
Ill. A x Wis. W23	38.8	43.5	27.7	16.0
Ill. A x Ill. R4	35.0	54.7	58.7	34.0
Wis. W23 x Ill. R4	38.6	69.4	61.3	35.5
Av.	37.5	53.2	49.2	28.5
Low attractive x *High attractive*				
Wis. W23 x Ind. WF9	39.4	54.3	43.5	25.2
Ill. A x Ind. WF9	38.3	56.1	49.0	28.4
Ill. R4 x CI.540	31.0	37.0	54.5	31.6
Ill. A x CI.540	34.6	51.0	56.4	32.7
Wis. W23 x CI.540	37.2	72.6	66.2	38.4
Ill. R4 x Ia. L317	36.2	72.6	69.2	40.1
Ill. R4 x Ind. WF9	37.5	98.8	94.4	54.7
Ill. A x Ia. L317	37.9	105.1	99.4	57.6
Wis. W23 x Ia. L317	36.9	107.4	105.1	60.9
Av.	36.6	72.8	70.8	41.1
High attractive x *High attractive*				
CI.540 x Ind. WF9	35.8	55.6	56.9	33.0
CI.540 x Ia. L317	31.4	70.4	94.6	54.7
Ind. WF9 x Ia. L317	37.9	98.6	98.9	57.3
Av.	35.0	74.8	83.5	48.2
L.S.D. 19:1	1.5	21.9	21.4	12.6

1945 Single-Cross Tests

The 1944 experiment was repeated in 1945, except inbred line Indiana Tr was substituted for USDA CI.540, since single-crosses with this line averaged 4 inches shorter in growth than the other combinations tested in 1944.

Experiments were planted on 2 dates to compare the attractiveness of these single-crosses under both first and second generation oviposition. However, the earlier planting was destroyed by livestock before any data were obtained, and only the planting made June 22 was available for study.

Statistical analysis showed highly significant differences among the entries in respect to all the variables measured. However, the number of eggs laid per plant on the different single-crosses was not significantly correlated with height at 50% oviposition or stage of development as measured in days from July 1 to mid-silking. Therefore, no adjustments were warranted in the number of eggs laid per plant (Table 2).

Although these single-crosses were tested under greatly differing environmental conditions and at a much later stage of plant development, the number of eggs laid per plant agreed consistently with those recorded in 1944. Ill. A x Wis.

TABLE 2. *Plant height and eggs laid by European corn borer moths during late summer on single-cross combinations of three low and three high attractive corn inbred lines. 1945. Lafayette, Indiana.*

Single Cross	Ave. Height in inches at 50% Oviposition	Mean Silk date days after July 1	No. of Eggs Laid Per Plant	
			Observed	Standardized to Mean of 40.0
Low attractive x *Low attractive*				
Ill. A x Wis. W23	73.3	58.8	8.9	9.9
Ill. A x Ill. R4	71.6	61.5	23.5	26.2
Wis. W23 x Ill. R4	78.3	60.3	24.3	27.1
Av.	74.4	60.2	18.9	21.1
Low attractive x *High attractive*				
Ill. A x Ind. WF9	71.5	58.4	12.5	13.9
Wis. W23 x Ind. WF9	76.2	59.2	14.5	15.9
Wis. W23 x Ia. L317	79.7	63.1	30.5	34.0
Ill. A x Ind. Tr	68.1	57.8	31.7	35.3
Ill. A x Ia. L317	77.4	61.5	35.4	39.4
Wis. W23 x Ind. Tr	76.9	59.1	37.2	41.4
Ill. R4 x Ind. WF9	76.4	61.6	40.3	44.9
Ill. R4 x Ia. L317	82.8	62.3	56.7	63.2
Ill. R4 x Ind. Tr	73.2	61.1	57.2	63.7
Av.	75.8	60.4	35.1	39.1
High attractive x *High attractive*				
Ind. Tr x Ind. WF9	75.2	58.9	41.8	46.6
Ind. WF9 x Ia. L317	82.5	63.0	48.3	53.8
Ind. Tr x Ia. L317	77.8	61.3	76.4	85.1
Av.	78.5	61.1	55.5	61.8
L.S.D. 19:1	2.0	1.1	16.1	17.9

W23 was again outstandingly unattractive. The most attractive single-cross was Ind. Tr x Ia. L317. The single-crosses involving Ill. A were among the 8 receiving the fewest eggs.

1946 Single-Cross Tests

The same combinations of single-crosses tested in 1945 were planted May 8 and retested under early summer oviposition in 1946.

Statistical analysis indicated highly significant differences among the single-crosses, both in respect to height and in the number of eggs laid (Table 3). After adjusting the number of eggs laid per plant for differences in height, highly significant differences still existed among the entries.

In the 1946 tests the single-cross Ill. A x Wis. W23 was not quite as unattractive as in the previous 2 seasons although it did not differ significantly from those single-crosses receiving fewer eggs. The single-cross Ind. Tr x Ia. L317 was again the most attractive one.

A comparison of the number of eggs laid on the single-crosses tested in 2 or more of the 3 seasons shows a very close agreement in the number of eggs received.

TABLE 3. *Plant height and eggs laid by European corn borer moths during early summer on single-cross combinations of three low and three high attractive corn inbred lines. 1946. Lafayette, Indiana.*

Single Cross	Ave. Height in inches at 50% Oviposition	Number of eggs laid per plant		
		Observed	Adjusted for Height Differences	Standardized to Mean of 40.0
Low attractive x *Low attractive*				
Ill. R4 x Wis. W23	27.4	25.9	17.8	20.5
Ill. A x Wis. W23	26.6	24.0	21.2	24.4
Ill. A x Ill. R4	23.6	17.3	31.2	36.0
Av.	25.9	22.4	23.4	27.0
Low attractive x *High attractive*				
Wis. W23 x Ind. WF9	28.1	23.7	12.6	14.5
Ill. A x Ind. WF9	27.7	29.8	20.9	24.1
Ill. R4 x Ind. WF9	27.0	36.3	31.3	36.1
Wis. W23 x Ind. Tr	27.4	40.1	32.9	37.9
Ill. A x Ind. Tr	24.0	23.0	34.7	40.0
Ill. R4 x Ind. Tr	24.8	30.2	37.4	43.1
Ill. R4 x Ia. L317	24.4	29.6	39.0	45.0
Wis. W23 x Ia. L317	26.2	43.9	43.4	50.0
Ill. A x Ia. L317	24.5	37.9	46.8	53.9
Av.	26.0	32.7	33.2	38.3
High attractive x *High attractive*				
Ind. WF9 x Ind. Tr	28.8	54.2	39.2	45.2
Ind. WF9 x Ia. L317	26.4	54.4	52.7	60.7
Ind. Tr x Ia. L317	25.0	48.9	55.0	63.4
Av.	26.7	52.5	49.0	56.4
L.S.D. 19:1	1.4	15.9	13.9	16.0

This is especially significant when we consider that each test was grown under different environmental conditions and stage of corn development.

Comparison of the 1944, 1945 and 1946 Tests

The single-cross Ill. A x Wis. W23 was outstanding in its unattractiveness in 1944 and 1945. In 1946 it was still among the least attractive single-crosses. All combinations involving Ill. A as one parent, with the exception of the single-cross Ill. A x Ia. L317 in 1944 and 1946, were among the least attractive combinations.

The single-cross Ind. Tr x Ia. L317 was the most attractive in 1945 and 1946, the 2 years it was tested. This high attractiveness is further substantiated by data from other tests in 1946. The high degree of attractiveness of Ia. L317 is indicated by the fact that in all years the single-crosses containing this line as one parent were among the 8 most attractive. In 1945 some reversals occurred, particularly those crosses involving Ia. L317 with Ill. A and Wis. W23.

TABLE 4. *Comparison of eggs laid by corn borer moths on single-crosses of three low and three high attractive corn inbred lines. 1944, 1945, 1946. Lafayette, Indiana.*

Single Cross	Number of eggs adjusted for height differences and standardized to a mean of 40.0 eggs per plant.			
	1944	1945	1946	Average
Low attractive x *Low attractive*				
Ill. A x Wis. W23	16.0	9.9	24.4	16.8
Ill. A x Ill. R4	34.0	26.2	36.0	32.1
Ill. R4 x Wis. W23	35.5	27.1	20.5	27.1
Av.	28.5	21.1	27.0	25.3
Low attractive x *High attractive*				
Wis. W23 x Ind. WF9	25.2	15.9	14.5	18.5
Ill. A x Ind. WF9	28.4	13.9	24.1	22.1
Ill. A x Ind. Tr	—	35.3	40.0	37.6
Wis. W23 x Ind. Tr	—	41.4	37.9	39.6
Ill. R4 x Ind. WF9	54.7	44.9	36.1	45.2
Wis. W23 x Ia. L317	60.9	34.0	50.0	48.3
Ill. R4 x Ia. L317	40.1	63.2	45.0	49.4
Ill. A x Ia. L317	57.6	39.4	53.9	50.3
Ill. R4 x Ind. Tr	—	63.7	43.1	53.4
Av.	44.4	39.1	38.3	40.5
High attractive x *High attractive*				
Ind. WF9 x Ind. Tr	—	46.6	45.2	45.9
Ind. WF9 x Ia. L317	57.3	53.8	60.7	57.3
Ind. Tr x Ia. L317	—	85.1	63.4	74.2
Av.	57.3	61.8	56.4	59.1
L.S.D. 19:1	12.6	17.9	16.0	13.2

L.S.D. 19:1 for Comparing Single-Crosses from Year to Year

1944 and 1945	1944 and 1946	1945 and 1946
21.8	17.3	20.7

In comparing the years 1945 and 1946, only the single-cross, Ind. Tr x Ia. L317 differed significantly in the number of eggs received. Between the years 1944 and 1946, only Ill. R4 x Ind. WF9 differed significantly in the 2 years. Between 1944 and 1945, 2 single-crosses, Wis. W23 x Ia. L317 and Ill. R4 x Ia. L317, received a significantly different number of eggs. Of a total of 45 single-crosses tested during the 3 years, only 4 differed significantly in 2 of the 3 years and none differed in all 3 years (Table 4). Such constancy in performance indicates strongly that the factors responsible for differences in attractiveness are genetic in nature and transmitted from inbred lines into single-cross combinations.

1947 Single-Cross Tests

Schlosberg (10) who continued studies in 1947, tested a group of high and low attractive inbred lines in single-cross combinations. Of the 12 studied, 3 represented crosses of low attractive lines, 3 crosses of high attractive lines and 6 were crosses of low x high attractive inbred lines.

The level of oviposition was very high, averaging approximately 100 eggs per plant. The group of single-crosses comprising low attractive inbred lines averaged 47.5 eggs per plant when height differences were taken into account, and 18.5 eggs when standardized to a mean of 40 eggs per plant. The intermediate group, comprising crosses of a low x high attractive inbred lines averaged 97.0 eggs per plant,

TABLE 5. *Plant height and eggs laid by European corn borer moths during early summer on single-cross combinations of three low and three high attractive corn inbred lines. 1947. Lafayette, Indiana. (Schlosberg—Annual Report 1947)**

Single Cross	Ave. Height in inches at 50% Oviposition	Number of eggs laid per plant		
		Observed	Adjusted for Height Differences	Standardized to Mean of 40.0
Low attractive x *Low attractive*				
Ill. A x Ill. R4	33	20.8	33.7	13.1
Ill. A x Wis. W23	33	33.6	46.5	18.1
Wis. W23 x Ill. R4	38	73.6	62.6	24.4
Av.	35	42.7	47.6	18.5
Low attractive x *High attractive*				
Ill. A x Ind. Tr	36	88.0	86.6	33.7
Ill. A x Ia. L317	34	80.0	88.1	34.3
Wis. W23 x Ind. Tr	40	110.4	89.8	35.0
Ill. R4 x Ind. Tr	37	97.6	91.4	35.6
Ill. R4 x Ia. L317	35	91.2	94.6	36.8
Wis. W23 x Ia. L317	37	137.6	131.4	51.2
Av.	36	100.8	97.0	37.8
High attractive x *High attractive*				
Ind. P8 x Ia. L317	34	147.2	155.3	60.5
N.J. A64 x Ia. L317	35	163.2	166.6	64.9
Ind. Tr x Ia. L317	36	185.6	184.2	71.7
Av.	35	165.3	168.7	65.7
L.S.D. 19:1		51.2	46.4	18.1

*Used with permission of the USDA Bureau of Entomology.

37.8 when standardized to a mean of 40 eggs. The group of single-crosses composed of 2 attractive inbred lines averaged 168.7 eggs per plant or 65.7 when standardized to 40 eggs per plant, these single-crosses averaged about the same number of eggs per plant as they received in 1944, 1945 and 1946. Exceptions were single-crosses Ill. A x Ill. R4 which had fewer, and Ill. R4 x Ia. L317, Ill. A x Ia. L317 and Ill. R4 x Ind. Tr which received more eggs (Table 5).

TABLE 6. *Plant height and eggs laid by European corn borer moths on 41 corn genotypes top-crossed on Illinois A and Iowa L317, adjusted for height and standardized to 40 eggs per-plant, with standardized number of eggs laid on them as inbreds in 1945. Lafayette, Indiana, 1946.*

Genotype	Height Inches		Number of Eggs						
			Observed		Adjusted		Standardized		
	A	L317	A	L317	A	L317	A	L317	Inbred
Ill. A	–	20.2	–	8.9	–	10.2	28.0	24.3	9.8
Ind. H22	22.2	–	19.4	–	14.6	–	34.8	–	17.0
Wis. W23	23.0	22.4	12.4	32.4	5.1	26.9	12.1	64.0	17.8
Ind. B2	21.0	19.7	13.5	13.6	12.3	16.4	14.4	29.3	24.8
Ill. R4	22.5	22.4	14.2	21.9	8.4	16.4	20.0	39.0	24.9
Ia. L289	22.2	20.7	13.6	14.4	8.8	14.2	21.0	33.8	25.6
N.J. A47	23.3	21.8	8.2	28.3	.1	24.7	.2	58.8	27.8
Kans. K55	20.0	17.8	9.6	11.9	11.5	20.6	27.4	49.0	30.4
Ind. 66 (3709B)	21.4	21.0	12.0	28.0	9.6	27.0	22.8	64.3	30.4
Ill. Hy	18.4	21.8	7.8	18.5	14.6	14.9	34.8	35.5	30.6
Ind. 33-16	22.0	19.7	17.4	13.2	17.0	15.1	31.4	40.5	30.7
Ind. H5	–	18.1	–	9.8	–	17.6	–	41.9	33.3
Kans. K4	20.3	20.4	3.8	21.0	4.8	21.7	11.4	51.7	34.4
Kans. K66	20.0	20.2	11.9	35.3	13.8	36.6	32.8	87.1	34.8
Kans. K64	16.8	18.0	4.4	8.4	16.2	16.5	38.6	39.3	36.7
Kans. K63	–	15.5	–	7.3	–	23.1	–	55.0	37.0
Ind. H21	21.8	20.4	14.8	29.4	11.2	30.1	26.7	71.7	38.5
Ill. 90	16.4	17.8	4.3	10.8	17.3	19.5	41.2	46.4	38.8
Mich. Ms1	22.7	21.4	25.6	27.4	19.4	25.0	46.2	59.5	38.9
Ill. Mi4	20.5	21.3	4.9	21.4	5.3	19.3	12.6	46.0	38.9
Wis. W26	23.3	21.4	20.4	21.5	12.2	19.1	29.0	45.5	39.2
Kans. K41	18.9	19.4	9.3	21.8	14.6	25.6	34.8	61.0	40.0
Ia. Os420	20.8	–	10.7	–	10.2	–	24.3	–	40.4
Ia. I234	18.6	18.5	5.8	12.2	12.0	18.7	28.6	44.5	40.7
Ind. P8	18.1	19.1	10.2	25.1	15.6	29.8	37.1	71.0	40.8
U.S. CI. 187-2	20.6	15.8	13.8	5.4	13.9	20.2	33.1	48.1	41.8
Ind. 38-11	21.8	22.1	27.6	27.6	9.5	23.1	22.6	55.0	42.1
N.J. B42	20.8	22.6	10.8	24.1	8.3	18.0	19.8	42.8	44.1
Kans. Kys	22.1	19.0	16.7	21.3	18.1	21.7	43.1	51.7	44.1
Ind. Tr	22.9	22.7	23.6	45.6	16.6	39.2	39.5	93.3	47.0
Ill. L	–	20.4	–	16.7	–	17.6	–	41.9	47.4
Mo. 940	20.0	20.2	3.8	22.0	5.7	23.3	13.6	55.5	49.2
Ill. R30	16.0	16.8	8.1	15.2	18.4	22.3	43.8	53.1	49.2
Ia. Pr	17.9	19.8	4.5	27.4	12.9	29.9	30.7	71.2	67.8
Kans. K44	18.3	19.4	4.3	19.5	11.5	23.3	27.4	55.5	71.8
N.J. A64	19.6	20.8	6.1	39.4	9.3	38.9	22.1	92.6	73.3
Ill. R7	18.4	17.7	8.9	10.1	15.7	19.1	37.4	45.5	82.2
Ia. Ldg	–	13.2	–	0.	–	22.8	–	54.3	82.6
Kans. K155	21.8	20.7	7.9	20.3	4.3	20.1	10.2	47.8	–
Ohio 51A	19.5	21.1	7.8	16.2	11.3	14.7	26.9	35.0	–
Ind. H23	17.4	16.6	8.0	4.8	17.9	17.2	42.6	40.9	–
Ia. Os426	20.9	19.6	11.5	25.9	10.7	19.9	25.5	69.3	–
L.S.D. 19:1	2.0	2.0	14.6	14.6	13.3	13.3	31.7	31.7	–

1946 Single-Cross Tests on Common Parent Inbred Lines

In another single-cross experiment, 41 inbred lines were tested in combination with low attractive inbred line Ill. A and high attractive inbred line Ia. L317. With few exceptions both crosses were represented in these studies (Table 6).

All crosses with Ill. A, with one exception, were less attractive than the companion cross with Ia. L317. There were statistically highly significant differences among the entries, both for average height at mid-oviposition as well as the number of eggs laid per plant. In addition, a breakdown of the variance of the number of eggs laid per plant among the single-crosses indicated that there were highly significant differences between an inbred cross with Ill. A and the companion inbred cross with Ia. L317 and also among the single-crosses containing Ill. A and those containing Ia. L317. There was a highly significant correlation between the number of eggs laid per plant and the height of the corn at mid-oviposition.

Among the single-crosses with Ill. A, New Jersey A47 x Ill. A received highly significant fewer eggs and Wis. W23 x Ill. A and Kansas K4 x Ill. A received significantly fewer eggs than the average of all the crosses with Ill. A. Two single-crosses, Michigan Ms1 x Ill. A and Ia. L317 x Ill. A, were significantly more attractive than the average of all the crosses with Ill. A.

Among the crosses with Ia. L317, Kansas K66 x Ia. L317 was significantly more attractive and Ind. Tr x Ia. L317 and New Jersey A64 x Ia. L317 were highly significantly more attractive than the average of all the Ia. L317 crosses. None of these single-crosses were significantly less attractive.

In Figure 1, the data from these paired single-crosses are plotted with the regression lines based on the relation of the single-crosses with low attractive Ill. A as a common parent, a second with the single-crosses with high attractive Ia. L317 as a common parent, and a third the general regression line based on the averages of those single-crosses where the inbred line was crossed on both Ill. A and Ia. L317. All the crosses with Ill. A were below the regression line based on the Ia. L317 crosses, indicating that all the Ill. A crosses were less attractive than the average of the Ia. L317 crosses. Only 4 crosses on Ill. A were above the general regression line. Of the crosses on Ill. A, 14 were between the general line and the regression line based on the crosses on Ill. A, and 17 were below the low attractive regression line. Conversely, all the single-crosses with Ia. L317 were above the general regression line, 15 were between this line and the one based on all the crosses on Ia. L317, and 14 were above the high attractive regression line.

Since inbred line Ill. A was selected for its low attractiveness and Ia. L317 for its high attractiveness to corn borer moths, the distribution of the single-crosses around these regression lines constitutes strong evidence that these inbred lines transmit their differences in attractiveness into single-crosses in which they occur. It may be further reasoned that those single-crosses with Ia. L317 as a common parent that fell above the regression line based on all the Ia. L317 crosses and those on Ill. A that fell below the regression line based on all Ill. A crosses received from the non-recurrent parent line factors which augmented the high attractiveness and low attractiveness of the factors contributed by Ia. L317 and Ill. A, respectively.

A study of the distribution of the deviations of the crosses on Ill. A and those on Ia. L317 about their respective regression lines indicated that the positive and negative deviations were not associated with the low attractiveness or high attract iveness of the non-recurrent inbred lines.

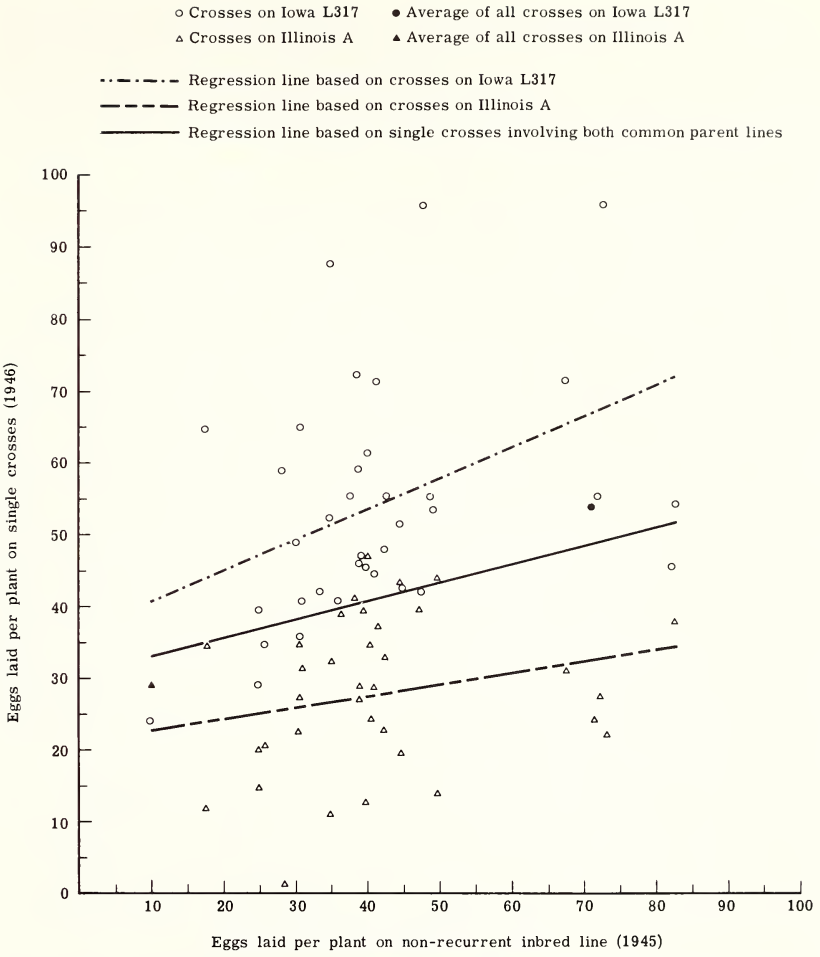

FIGURE 1. *Relationship of standardized number of eggs laid on single-crosses and number laid on the non-recurrent inbred lines. Lafayette, Indiana. 1946. (Table 7).*

Corn Genotypes Contribution to Single-Crosses

Although it has been demonstrated that wide differences exist in the number of eggs laid on different kinds of corn (1,4), practical use of such differences depending on evidence that the factors responsible for these differences in attractiveness are transmissible into single-cross combinations and are therefore available for genetic use. If the differences in attractiveness are controlled by genes in the genetic makeup of inbred lines, then there is the possibility of obtaining recombinations of these factors through breeding techniques. Such recombinations could result in the development of new inbred lines of extremely low attractiveness to corn borer moths, or inbred lines in present use could be reduced in attractiveness. This would result in hybrid corn for commercial production with less attractiveness to corn borer moths.

To analyze the relationship of the single-crosses used in the all-possible combination tests in 1944, 1945 and 1946, and the inbred lines comprising them, the inbred lines were assigned rankings based upon their attractiveness when tested as inbreds (4). The average number of eggs laid by corn borer moths on the inbred lines used in these all-possible single-cross studies and the relative rankings assigned them are given in Table 7.

Using these assigned rankings of the inbred lines for attractiveness, the single-crosses containing them were grouped into 9 classes based upon the combined total ranking of the inbreds comprising each single-cross. Thus, the single cross Ill. A x Ind. WF9 would have a rating of 1 plus 5 or 6 as an index of its potential attractiveness. Similarly, USDA CI.540 x Wis. W23 would have a rating of 6 (4 plus 2). After the 45 single-crosses tested in 1944, 1945 and 1946 were assigned to the classes representing their potential attractiveness, the number of eggs laid on them in each season, adjusted for height differences and standardized to a mean of 40 eggs per plant, were averaged. This was used as the best expression of the attractiveness of each particular class. To obtain a comparable figure on the number of eggs laid on the inbreds comprising the single-crosses in these classes, the number of eggs laid on each inbred as such was multiplied by the number of times each inbred occurred in the pedigress in each class and the total figure was divided by the number of inbreds involved. For example, to obtain the average performance of the inbred lines involved in the pedigress of the single-crosses occurring in class 10, inbred line USDA CI.540 occurred once, Ind. Tr twice and Ia. L317 three times. This gave a total of 46.8, the average number of eggs USDA CI.540 received as an inbred, plus 2 times 47.0 (94.0) for inbred line Ind. Tr, plus 3 times 71.0 (213.0) for Ia. L317 making a total of 353.8. Since there were 6 inbred lines involved in the 3 single-crosses in this group, this total was divided by 6 to obtain an average of 59.0, the potential number of eggs the inbred lines in these three single-crosses would have received (Table 8).

There was a highly significant correlation coefficient of 0.955 between the number of eggs laid on the single-crosses in each class and the inbred lines comprising them. Approximately 91.2 percent (R^2 x 100) of the variation in the number of eggs laid on the single-crosses can be accounted for by the number of eggs laid on the parent lines. When the data are plotted (Figure 2) the closeness of the data to the regression line indicates the high degree of assocation between the variables.

TABLE 7. *Rank of attractiveness to European corn borer moths of the inbred lines used in producing the combinations tested in 1944, 1945 and 1946. Lafayette, Indiana.*

Inbred Line	Average Number of Eggs Laid Per Plant*	Relative Attractive Rank
Illinois A	16.4	1
Wisconsin W23	17.9	2
Illinois R4	30.6	3
USDA CI.540	43.7	4
Indiana WF9	47.9	4
Indiana Tr	53.8	5
Iowa L317	64.8	6

*Data taken from tests as inbred lines (4).

TABLE 8. *Single-crosses tested in 1944, 1945 and 1946 arranged by classes based on the attractive indices of inbred lines comprising them, with the number of corn borer eggs laid per plant. Lafayette, Indiana.*

Pedigree of Single Classes	Attractive Class Index	No. of single Crosses In Class	No. of Eggs Laid Per Plant*	
			Inbred Lines	Single Crosses
Ill. A x Wis. W23	3	3	17.2	16.8
Ill. A x Ill. R4	4	3	23.5	32.1
Ill. A x CI.540 Ill. A x Ind. WF9 Wis. W23 x Ill. R4	5	7	28.5	26.0
Ill. A x Ind. Tr Wis. W23 x CI.540 Wis. W23 x Ind. WF9	6	6	33.3	28.2
Ill. A x Ia. L317 Wis. W23 x Ind. Tr Ill. R4 x CI.540 Ill. R4 x Ind. WF9	7	9	38.7	44.2
Wis. W23 x Ia. L317 Ill. R4 x Ind. Tr CI.540 x Ind. WF9	8	6	42.4	47.4
Ill. R4 x Ia. L317 Ind. Tr x Ind. WF9	9	5	49.0	48.0
CI.540 x Ia. L317 Ind. WF9 x Ia. L317	10	4	55.8	56.6
Ind. Tr x Ia. L317	11	2	59.3	59.3

*Adjusted for differences in plant height at 50 percent oviposition and standardized to a mean of 40 eggs per plant.

Also when the regression line calculated from the data is compared with the line that could be postulated if the attractive characters in the inbred lines were transmitted 100 percent into their single-cross combinations, it is readily apparent the difference was very small.

If we assume that there was a perfect relationship between the attractiveness of the inbred lines to European corn borer moths and the crosses comprised of these lines, then the regression equation would read $Y = X$, with a regression coefficient of 1.0. The regression coefficient based on the actual data is 0.966, with a standard error of 0.258. Comparing the data in Table 8 and the regression equation of $Y = X$, the standard error of the regression coefficient 1.0 is 0.443. The difference between the two regression coefficients is 0.034 ± 0.647, indicating that the regression coefficient based on the data, 0.966, did not differ significantly from 1.0.

From the foregoing comparison, it is readily apparent that inbred lines as a group transmit the qualities that affect their attractiveness to European corn borer moths to the single-crosses in which they occur. It is also apparent that the degree of attractiveness in the inbred lines is transmitted in a similar degree into

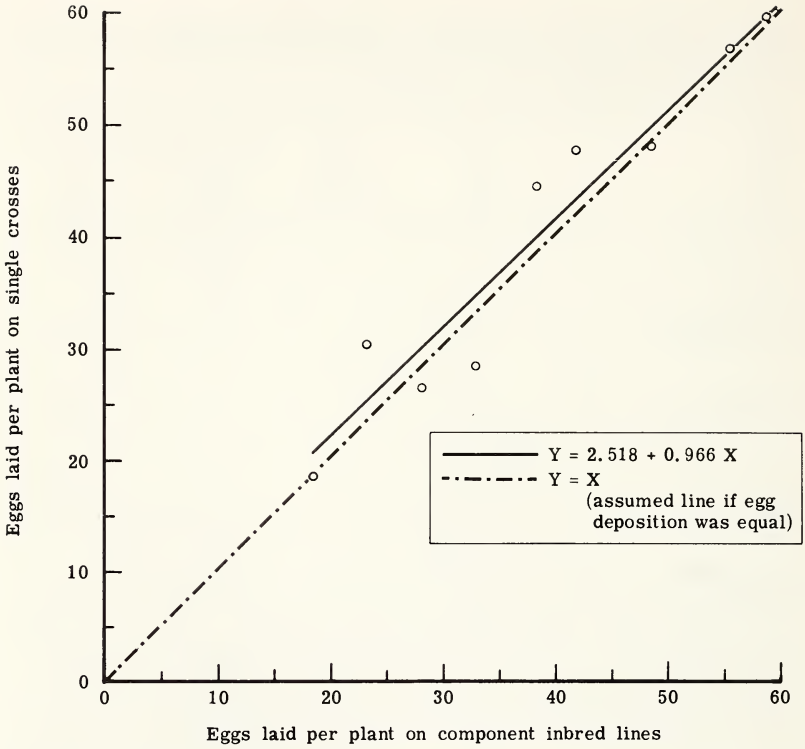

FIGURE 2. *Relation of number of eggs laid by European corn borer moths on single-cross hybrids to the number of eggs laid in the component inbred lines. Lafayette, Indiana. (Table 8).*

single-cross combinations of these inbred lines. Thus, the characters which influence the oviposition by corn borer moths on inbred lines of corn are genetic in nature and as such would lend themselves to breeding techniques.

Summary

Corn resistance to attack by the European corn borer has been categorized into 3 phases: attractiveness, antibiosis and tolerance (2). Tolerance has not been investigated although there is evidence that it may have an important effect in other host-insect relationships. Antibiosis has been under investigation for the past fifty years and significant differences in survival have been found. Antibiosis is most effective during the early stages of plant development. Distinct differences in genotype attractiveness have been recently reported (1,4). The data from these experiments clearly indicate that corn genotype attractiveness to ovipositing European corn borer moths is transmitted in a high degree to single-crosses and therefore is subject to genetic manipulation. In producing corn genotypes resistant to corn borer attack, the use of lower attractiveness has several advantages: (a) The differences in attractiveness are constant over the entire period of corn development; (b) Attractiveness becomes increasingly more effective as the level of oviposition increases; and (c) In the breeding program plants can be evaluated

for low attractiveness and used in the current breeding season. If low attractiveness can be combined with high antibiosis, losses from the European corn borer could be greatly reduced.

Acknowledgment

This research was carried out at Lafayette, Indiana, United States Department of Argriculture Laboratory in cooperation with Purdue Agriculture Experiment Station.

The author expresses grateful appreciation to Arwin V. Provonsha for the preparation of the figures, and to my wife, Laura W. Everly, for her assistance in preparing and typing of the manuscript.

Literature Cited

1. EVERLY, R. T. 1946. Studies on the Attractiveness of Dent Corn to Moths of the European Corn Borer. (Abstract). Proc. Ind. Acad. Sci. 56:145.
2. EVERLY, R. T. 1946. Resistance Studies with the European Corn Borer in Dent Corn. Proc. North Cent. Br. E.S.A. 1:82-83.
3. EVERLY, R. T. 1959. Influence of Height and Stage of Development of Dent Corn on Oviposition by European Corn Borer Moths. Ann. Entomol. Soc. Am. 52:272-279.
4. EVERLY, R. T., W. D. GUTHRIE and F. F. DICKE. 1979. Attractiveness of Corn Genotypes to Ovipositing European Corn Borer Moths. USDA Agric. Rev. and Manuals Sci. and Educ. Adm. ARM-NC-8. Dec. 14p.
5. FICHT, G. A. 1931. Some Observations on the Planting Date of Corn and its Relation to Corn Borer Populations. J. Econ. Entomol. 24:380-386.
6. JONES, D. W., H. G. WALKER and L. D. ANDERSON. 1939. The European Corn Borer on the Eastern Shores of Virginia. Va. Truck Expt. Sta. Bull. 102.
7. KRASSLISTICHIK, I. M. 1916. Report of the Bio-Entomological Station. Bessarabia. (Russia) for 1914. Kishinen. (Also Rev. Appl. Entomol. Series A 5:253-255).
8. MEYERS, M. T., L. L. HUBER, C. R. NEISWANDER, F. D. RICHEY, and G. H. STRINGFIELD. 1937. Experiments on Breeding Corn Resistant to the European Corn Borer. USDA Tech. Bull. 583.
9. NEISWANDER, C. R., and L. L. HUBER. 1929. Height and Silking as Factors Influencing European Corn Borer Population. Ann. Entomol. Soc. Am. 22:527-542.
10. SCHLOSBERG, M. 1947. Annual Report of European Corn Borer Research for 1947. USDA Bur. Entomol.