

COMPARISONS OF LABORATORY AND FERAL STRAINS
OF *SPODOPTERA FRUGIPERDA* AND *HELICOVERPA ZEA*
(LEPIDOPTERA: NOCTUIDAE) IN LABORATORY
AND FIELD BIOASSAYS

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ABSTRACT

The effects of resistant corn entries and resistant silk-diets on the growth and development of fall armyworm and corn earworm from a laboratory and a $\frac{3}{4}$ wild colony were compared in laboratory and field studies. For both species, there were significant interactions between insect strain and diet treatments. Compared to the laboratory strains, the $\frac{3}{4}$ wild strains produced lighter larvae and required longer developmental times when reared on diets with and without resistant silks. Larval growth of both insect strains was significantly retarded by the addition of resistant silks to the diets. In field studies, the $\frac{3}{4}$ wild strains generally performed better than the laboratory strains. For both insect species, interactions between insect strains and corn lines were observed. Strain differences for all measured parameters were greater for the corn earworm than for the fall armyworm. Results from these studies indicate that research on plant resistance for the fall armyworm and the corn earworm would better predict the relative levels of resistance among different corn lines and among different silk diets if $\frac{3}{4}$ wild colonies were established annually, and if insects from these $\frac{3}{4}$ wild colonies were used in conducting laboratory and field bioassays.

Key Words: Plant Resistance; maize; corn silks; meridic diets

RESUMEN

Los efectos de la introducción de líneas resistentes de maíz y de dietas con estigmas resistentes en el crecimiento y desarrollo del gusano cogollero del maíz y del gusano del elote del maíz de una colonia de laboratorio y de una colonia $\frac{3}{4}$ salvaje fueron comparadas en estudios de laboratorio y de campo. Para ambas especies se notaron interacciones significativas entre el tipo de insecto y los tratamientos de dieta. En comparación con las colonias de laboratorio, las colonias $\frac{3}{4}$ salvajes produjeron larvas más ligeras y que requirieron períodos de desarrollo más largos cuando se criaron en dietas con o sin estigmas resistentes. El crecimiento larval de ambos tipos de insecto fue significativamente retardado por la adición de estigmas resistentes a las dietas. En estudios de campo, las colonias $\frac{3}{4}$ salvajes resultaron mejores que las colonias de laboratorio. En ambas especies se observaron interacciones entre los tipos de insecto y las líneas de maíz. En todos los parámetros medidos las diferencias entre las colonias fueron más grandes para el gusano del elote que para el gusano cogollero. Los resultados de estos estudios indican que investigaciones sobre resistencia del maíz contra el gusano cogollero y el gusano del elote podrían predecir mejor los niveles relativos de resistencia entre líneas diferentes de maíz y entre diferentes dietas de estigmas si se establecieran anualmente colonias $\frac{3}{4}$ salvajes y si insectos de estas colonias $\frac{3}{4}$ salvajes se utilizaran para conducir bioensayos de laboratorio y de campo.

The fall armyworm, *Spodoptera frugiperda* (J. E. Smith), and the corn earworm, *Helicoverpa zea* (Boddie), are two of the most destructive pests of corn, *Zea mays* L., in the United States. The use of corn varieties resistant to these insect pests is an ideal method to reduce losses caused by insect feeding and to reduce the population density of insect pests developing on corn. Resistant corn varieties can be used as the primary method of insect control or as a component of an integrated pest management scheme (Wiseman et al. 1983). Corn germplasm resistant to the fall armyworm (Wiseman et al. 1976, Williams & Davis 1997a, Wiseman et al. 1981) and to the corn earworm (Straub & Fairchild 1970, Wiseman & Davis 1990) have been discovered.

Rearing fall armyworm and corn earworm in laboratory colonies has been an important part of research programs developing corn varieties resistant to these insect pests (Davis & Guthrie 1992). Laboratory reared insects are used to artificially infest corn plants in the field, and fresh leaves and silk diets and reconstituted leaf and silk diets in the laboratory (Davis et al. 1989, Williams & Davis 1997b, Wiseman et al. 1981, Wiseman et al. 1983, Wiseman & Wilson 1987). Although natural populations or field collections of fall armyworm and corn earworm can be useful to researchers in plant resistance, laboratory colonies of these pests provide a reliable source of insects for these studies and thereby allow for an expanded research program. Because laboratory colonies of fall armyworm and corn earworm are relied upon by many researchers to conduct plant resistance studies, it is important that the insects in the laboratory colonies are physiologically and behaviorally equivalent to their wild counterparts (Davis & Guthrie 1992). The infusion of new genes from wild insects into laboratory colonies can improve the field performance of laboratory-reared insects (Young et al. 1975). As a precautionary measure, some researchers start new laboratory colonies or infuse new genes into their laboratory colony each year (Davis & Guthrie 1992). In this study, our objectives were to compare the performance of a laboratory colony and a $\frac{3}{4}$ wild colony of the corn earworm and fall armyworm when reared on silk-diets or on corn plants in the field with varying levels of resistance.

MATERIALS AND METHODS

Laboratory corn earworm and fall armyworm larvae were obtained from cultures maintained on a corn-soy-milk solids and pinto bean diets, respectively, (Perkins 1979; Burton & Perkins 1989) at the Insect Biology and Population Management Research Laboratory, Tifton, GA. The laboratory corn earworm culture is sustained in a heterozygous state by maintaining a series of carefully controlled crosses (Young et al. 1976). A $\frac{3}{4}$ wild strain was developed for both the corn earworm and fall armyworm by crossing wild males with laboratory females. Female progeny ($\frac{1}{2}$ wild) from these crosses were mated with wild males (Young et al. 1975). Wild corn earworm males were collected in light traps during early and late October, 1996. Wild fall armyworm males were collected as larvae from whorl corn during late August and late September, 1996.

Laboratory studies were conducted on the $\frac{3}{4}$ wild, corn earworm strain during the 2nd and 3rd generation. Field studies were conducted on the $\frac{3}{4}$ wild, corn earworm strain during the 5th and 6th generation. Laboratory studies were conducted on the $\frac{3}{4}$ wild, fall armyworm strain during the 3rd and 4th generation, and field studies were conducted during the 7th and 8th generations.

Two laboratory experiments, one for the corn earworm and the other for the fall armyworm, were conducted as a split plot design with 30 replications and 1 cup per replication. Whole plots were the laboratory strain insects and the $\frac{3}{4}$ wild strain insects, and subplots were diet treatments. Diets were made using 50 and 25 mg Zapalote

Chico' (resistant) and 50 mg 'Stowell's Evergreen' sweet corn oven dried silks mixed (per 1 ml diluted diet) in pinto bean diet diluted at a rate of 3 ml of bean diet/2 ml of water. Controlled diets for each experiment were regular pinto bean diet (Burton & Perkins 1989) and a celufil check at the rate of 50 mg celufil/ml of dilute diet. The diet mixtures were dispensed into 30 ml plastic diet cups of \approx 10 ml per cup. The diets were allowed to cool for \approx 2 h, after which 1 neonate was introduced into each cup and the cup was capped. Weight of larvae (8 d for the corn earworm and 9 d for the fall armyworm), days to development to pupation and weight of pupae were recorded. Both experiments were held in a controlled environment room maintained at $28 \pm 2^\circ\text{C}$ and $75 \pm 2\%$ RH with a photoperiod of 14:10 (L:D).

Two field experiments with two planting dates each were conducted in 1997 for the corn earworm and fall armyworm. Four dent corn entries (resistant 'MpSWCB-4' and 'GT-FAWCC(C5)' or susceptible 'Cacahuacintle X's' and 'Pioneer 3369A') were selected for comparison against the fall armyworm. Zapalote Chico and 'Zimmerman Z-63W' (resistant) and Stowell's Evergreen and Pioneer 3369A (susceptible) were selected for comparison against the corn earworm.

The fall armyworm tests were seeded on 13 May, 1997 and 29 May, 1997 at Tifton, GA. The corn earworm tests were seeded on 2 April, 1997 and 22 April, 1997 at Tifton, GA. Test plots consisted of single rows 6.1 m long and 0.9 m apart. Plants were thinned to ca. 30 cm apart. Recommended agronomic practices were followed for both tests and planting dates.

A split plot design with 6 replications was used with whole plots being a check plot with no infestation, infested with the $\frac{3}{4}$ wild strain and infested with the laboratory culture of the fall armyworm or corn earworm, respectively. Subplots were corn entries.

Whorl stage plants (10 leaves) were infested with a total of 30 fall armyworm neonates (2 applications of 15/plant on the same day) using the 'Bazooka' method (Wiseman 1989). Counts of larvae and weight of biomass were made per 5 plants at 7 d after infestation (DAI) and rated at 7 and 14 DAI using a visual rating scale of 0-9 (Davis et al. 1992), where 0 = no damage and 9 = whorl destroyed.

Corn earworm larvae were infested on two-day-old silks at the rate of 5 larvae/silk mass. Counts of larvae and weight of their biomass per 5 ears were made at 7 DAI and injury ratings were made at 18 DAI (Wiseman 1989).

Data from laboratory tests and field tests were analyzed by PROC GLM (SAS Institute 1989). When significant differences were indicated, means were separated by least significant differences (LSD) at $P = 0.05$ (SAS Institute 1989).

RESULTS AND DISCUSSION

Laboratory Experiments

Studies with the corn earworm revealed a significant interaction between insect strain and diet treatments for the 8-d larval weights (Table 1). Larvae from the laboratory colony performed significantly better on the bean diet than on the celufil and susceptible diets. Larvae from the $\frac{3}{4}$ wild colony performed significantly better on the celufil diet than on the bean and susceptible diets. Larval growth of both insect strains was significantly retarded by the addition of resistant silks to the diets. In general, the 8-d larval overall diet weights of the $\frac{3}{4}$ wild strain were about half the 8-d larval weights of the laboratory strain. The mean 8-d larval weight across diet treatments was 169.4 mg for the laboratory strain and 80.3 mg for the $\frac{3}{4}$ wild strain. There was a significant interaction between insect strain and diet treatments for the devel-

TABLE 1. EFFECT OF DIET TREATMENTS AND CORN EARWORM STRAIN ON WEIGHT (MG) OF 8-D-OLD LARVAE, DEVELOPMENTAL TIME OF LARVAE (DAYS TO PUPATION), AND PUPAL WEIGHT (MG).

Insect Strain	Diet Treatment ¹					Mean
	BNCK	CLCK	SEG25	ZC25	ZC50	
	<i>Weight (mg) of 8-d-old larvae</i>					
Laboratory	278.9 Aa	221.4 Ab	202.9 Ab	102.3 Ac	32.8 Ad	169.4
¾ Wild	103.6 Bb	139.9 Ba	106.5 Bb	36.1 Bc	7.6 Ad	80.3
Mean	201.4	180.6	159.2	70.5	20.9	
	<i>Developmental time of larvae (days to pupation)</i>					
Laboratory	13.1 Ad	14.3 Acd	15.4 Ac	17.7 Ab	26.9 Aa	17.0
¾ Wild	18.3 Bc	18.8 Bc	18.9 Bc	21.2 Bb	37.3 Ba	21.6
Mean	15.1	16.4	16.9	19.3	30.7	
	<i>Pupal weight (mg)</i>					
Laboratory	554.6 Aa	531.3 Aa	528.9 Aa	467.8 Ab	287.3 Ac	484.9
¾ Wild	398.5 Bb	414.9 Bab	432.2 Bab	437.3 Aa	321.7 Ac	409.0
Mean	495.6	478.6	488.3	453.9	299.8	

¹BNCK = Bean check diet; CLCK = Celufil check; SEG25 = 'Stowell's Evergreen' 25 mg silks; ZC25 = 'Zapalote Chico' 25 mg silks; ZC50 = 'Zapalote Chico' 50 mg silks. Horizontal means followed by the same lowercase letter are not significantly different, and column means for each parameter followed by the same uppercase letter are not significantly different ($P < 0.05$) as separated by LSD (SAS Institute 1989).

opmental time of corn earworm to pupation (Table 1). The laboratory strain required significantly more time to develop on diet containing susceptible silks than on the bean diet; however, there was no difference in the developmental time for the ¾ wild strain on these two diets. The number of days to pupation for both insect strains was significantly increased by the addition of resistant silks to the diets. The ¾ wild strain required a greater number of days to pupate on each diet treatment than did the laboratory strain. There also was a significant interaction between insect strain and diet treatments for the weight of corn earworm pupae (Table 1). Addition of resistant silks to the diet significantly reduced the weight of pupae for the laboratory strain. However, ¾ wild strain pupae that developed on the diet with the lower concentration of resistant silks were significantly heavier than pupae that developed on the bean diet. Except for the diet with the higher concentration of resistant silks, each diet treatment yielded heavier laboratory strain pupae than ¾ wild strain pupae.

Studies with the fall armyworm also showed a significant interaction between insect strain and diet treatments for the 9-d larval weights (Table 2). Larvae from both fall armyworm strains performed significantly better on the bean diet than on the celufil and susceptible diets. Larval growth of both insect strains was significantly retarded by the addition of resistant silks to the diets. Larvae from the ¾ wild strain weighed about 84% the weight of larvae from the laboratory strain when reared on the bean diet, and weighed about 50% the weight of larvae from the laboratory strain when reared on the resistant silk-diets. There was a significant interaction between insect strain and diet treatments for the developmental time of fall armyworm to pupation (Table 2). The number of days to pupation for both insect strains was signifi-

TABLE 2. EFFECT OF DIET TREATMENTS AND FALL ARMYWORM STRAIN ON WEIGHT OF 9-D-OLD LARVAE, DEVELOPMENTAL TIME (DAYS TO PUPATION), AND PUPAL WEIGHT (MG).

Insect Strain	Diet Treatments ¹					Mean
	BNCK	CLCK	SEG25	ZC25	ZC50	
<i>Weight (mg) of 9-d-old larvae</i>						
Laboratory	212.0 Aa	187.1 Ab	155.5 Ac	35.1 Ad	6.1 Ae	119.2
¾ Wild	177.1 Ba	148.4 Bb	92.1 Bc	17.4 Ad	3.2 Ad	87.6
Mean	194.5	167.8 a	123.8	26.2	4.6	
<i>Developmental time of larvae (days to pupation)</i>						
Laboratory	14.4 Aa	15.5 Aab	16.1 Ab	20.4 Ac	27.2 Ad	18.7
¾ Wild	15.9 Ba	17.1 Bab	17.9 Bb	22.2 Bc	33.7 Bd	21.4
Mean	15.2	16.2	17.0	21.3	30.4	
<i>Pupal weight (mg)</i>						
Laboratory	305.4 A	273.2 A	272.6 A	243.4 A	159.9 A	159.7 a
¾ Wild	297.9 A	281.7 A	297.4 B	247.1 A	176.7 A	274.5 b
Mean	301.3 a	277.5 b	285.7 b	245.3 c	165.8 d	

¹BNCK = Bean check diet; CLCK = Celufil check; SEG25 = 'Stowell's Evergreen' 25 mg silks; ZC25 = 'Zapalote Chico' 25 mg silks; ZC50 = 'Zapalote Chico' 50 mg silks. Horizontal means followed by the same lowercase letter are not significantly different, and column means for each parameter followed by the same uppercase letter are not significantly different ($P \leq 0.05$) as separated by LSD (SAS Institute 1989).

cantly increased by the addition of resistant silks to the diets. Developmental time on bean diet for ¾ wild larvae was about 1.5 d longer than the developmental time for laboratory larvae. When larvae were reared on the more resistant silk-diet, the developmental time for ¾ wild larvae was about 6.5 d longer than the developmental time for laboratory larvae. Pupae from the ¾ wild strain were significantly heavier than pupae from the laboratory strain (Table 2). Larvae that developed on bean diet produced significantly heavier pupae than did larvae that developed on the celufil and susceptible silk diets. Resistant silk diets produced significantly lighter pupae than the other diet treatments.

Field Experiments

The number of corn earworm larvae collected from 5 corn ears 7 d after infestation was significantly influenced by insect strain and corn line (Table 3). There was a significant interaction between corn line and insect strain for the first planting date but not for the second planting date. For each planting date, more larvae were found in the ¾ wild strain treatment than in the laboratory strain treatment. More larvae were produced on Stowell's Evergreen than the other corn lines for the first planting date, and more larvae were produced on P3369A than the other corn lines for the second planting date. The weight of larvae per 5 corn ears was similar to the number of larvae per 5 corn ears. Again, there was a significant interaction between corn line and insect strain for the first planting date but not for the second planting date (Table 4). Also,

TABLE 3. EFFECT OF CORN LINES AND CORN EARWORM STRAIN ON LARVAL SURVIVAL AT 7 DAYS AFTER INFESTATION (NO. OF LARVAE/5 EARS).

Insect Strain	Corn Line ¹				Mean
	SEG	ZC	Z63W	P3369A	
<i>First Planting Date (2 April)</i>					
Check	3.3 Aa	1.5 Aa	1.3 Aa	1.8 Aa	2.0
Laboratory	8.2 Ba	2.2 Ab	2.8 ABb	2.8 Ab	4.0
¾ Wild	13.3 Ca	4.5 Ab	5.5 Bb	3.8 Ab	6.8
Mean	8.3	2.7	3.2	2.8	
<i>Second Planting Date (22 April)</i>					
Check	3.2 Ab	0.2 Ac	7.0 Aa	9.8 Aa	5.0 A
Laboratory	7.2 Ba	1.8 Ab	6.3 Aa	8.3 Aa	5.9 AB
¾ Wild	11.3 Ca	2.8 Ab	7.5 Ab	10.5 Aa	8.0 B
Mean	7.2 b	1.6 c	6.9 b	9.6 a	

¹SEG = 'Stowell's Evergreen'; ZC = 'Zapalote Chico'; Z63W = 'Zimmerman Z-63W'; P3369A = 'Pioneer 3369A'. Horizontal means followed by the same lowercase letter are not significantly different, and column means for each planting date followed by the same uppercase letter are not significantly different ($P \leq 0.05$) as separated by LSD (SAS Institute 1989).

for each planting date, the weight of larvae per 5 corn ears was greater for the ¾ wild strain than for the laboratory strain, however, the difference was not significant. For each planting date, the weight of larvae per 5 corn ears was significantly greater for

TABLE 4. EFFECT OF CORN LINES AND CORN EARWORM STRAIN ON WEIGHT OF LARVAE 7 DAYS AFTER INFESTATION [WEIGHT (MG) OF LARVAE/5 EARS].

Insect Strain	Corn Line ¹				Mean
	SEG	ZC	Z63W	P3369A	
<i>First Planting Date (2 April)</i>					
Check	115.7 Aa	56.3 Aa	2.7 Aa	15.3 Aa	47.5
Laboratory	274.8 Ba	30.3 Ab	86.8 Ab	32.3 Ab	106.1
¾ Wild	349.5 Ba	126.5 Abc	24.0 Abc	9.7 Ac	127.4
Mean	246.7	71.1	37.8	19.1	
<i>Second Planting Date (22 April)</i>					
Check	222.7 Aa	0.5 Ab	99.7 Aab	152.5 Aab	118.8 A
Laboratory	244.3 Aa	21.2 Ab	179.7 Aab	135.5 Aab	145.2 A
¾ Wild	321.5 Aa	192.7 Aab	81.8 Ab	100.0 Ab	174.0 A
Mean	262.8 a	71.4 b	120.4 b	129.3 b	

¹SEG = 'Stowell's Evergreen'; ZC = 'Zapalote Chico'; Z63W = 'Zimmerman Z-63W'; P3369A = 'Pioneer 3369A'. Horizontal means followed by the same lowercase letter are not significantly different, and column means for each planting date followed by the same uppercase letter are not significantly different ($P \leq 0.05$) as separated by LSD (SAS Institute 1989).

Stowell's Evergreen than for the other corn lines. Measurements of the depth of ear penetration 18 d after infestation for the first planting date revealed that larvae from the 3/4 wild strain penetrated significantly deeper into the ear than did the larvae from the laboratory strain or larvae from natural infestation (Table 5). Depth of ear penetration was significantly greater for Stowell's Evergreen than for the other corn lines. Results of ear penetration for the second planting date was similar except that there was a significant interaction between corn line and insect strain.

Results from the field study with fall armyworm showed significant interactions between corn lines and insect strain for each of the measured parameters for each planting date. For the first planting date the mean number of 3/4 wild larvae per 5 plants was about twice the number of laboratory larvae per 5 plants (Table 6). The mean number of larvae per plant for the second planting date was similar for the 3/4 wild and laboratory strains (18.6 and 21.9, respectively). No larvae were found in the check plots. More larvae were found in the susceptible corn plots than in the resistant corn plots for both planting dates. The weight of larvae per 5 plants for each corn line was greater for the laboratory strain than for the 3/4 wild strain for the second planting date (Table 7). Also, the weight of larvae per 5 plants was greater for susceptible corn lines than for resistant corn lines. Weight of larvae per 5 plants was not recorded for the first planting date. The 7-d visual damage rating for the 3/4 wild strain was greater than the 7-d visual damage rating for the laboratory strain for the first planting date (Table 8). For the second planting date the 7-d visual rating was similar for the 3/4 wild and laboratory strains (2.5 and 2.7, respectively). No damage was found in the check plots. Damage ratings were higher in the susceptible corn plots than in the resistant corn plots for both planting dates. The visual damage ratings after 14 d were higher in each case than the damage ratings taken after 7 d (Table 9). Otherwise, the 14-d damage ratings were similar to the 7-d damage ratings when comparing between insect strains and among corn lines.

TABLE 5. EFFECT OF CORN LINES AND CORN EARWORM STRAIN ON DEPTH (CM) OF LARVAL PENETRATION INTO THE EAR 18 DAYS AFTER INFESTATION.

Insect Strain	Corn Line ¹				Mean
	SEG	ZC	Z63W	P3369A	
<i>First Planting Date (2 April)</i>					
Check	3.8 Aa	2.6 Ab	1.6 Ac	2.5 Abc	2.5 A
Laboratory	3.6 Aa	2.5 Ab	1.9 Ab	2.8 Aab	2.7 A
3/4 Wild	5.1 Ba	3.1 Ab	2.7 Ab	2.8 Ab	3.4 B
Mean	4.1 a	2.7 b	2.1 c	2.5 bc	
<i>Second Planting Date (22 April)</i>					
Check	5.5 Aab	2.6 Ac	4.7 Ab	6.1 Aa	4.7
Laboratory	7.6 Ba	3.2 ABc	4.8 Ab	5.9 Ab	5.4
3/4 Wild	8.1 Ba	4.4 Bb	5.1 Ab	5.8 Ab	5.9
Mean	7.1	3.4	4.9	5.9	

¹SEG = 'Stowell's Evergreen'; ZC = 'Zapalote Chico'; Z63W = 'Zimmerman Z-63W'; P3369A = 'Pioneer 3369A'. Horizontal means followed by the same lowercase letter are not significantly different, and column means for each planting date followed by the same uppercase letter are not significantly different ($P \leq 0.05$) as separated by LSD (SAS Institute 1989).

TABLE 6. EFFECT OF CORN LINES AND FALL ARMYWORM STRAIN ON LARVAL SURVIVAL AT 7 DAYS AFTER INFESTATION (NO. OF LARVAE/5 PLANTS).

Insect Strain	Corn Line ¹				Mean
	CACAH	GT-FAWCC (C5)	MpSWCB-4	P3369A	
<i>First Planting Date (13 May)</i>					
Check	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	0.0
Laboratory	39.3 Ba	12.8 Bb	7.3 A	48.2 Ba	26.9
¾ Wild	78.7 Ca	40.8 Cc	27.8 Bd	58.8 Bb	51.7
Mean	39.3	16.5	11.7	34.3	
<i>Second Planting Date (29 May)</i>					
Check	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	0.0
Laboratory	34.8 Ba	14.0 Bc	13.2 Bc	25.7 Bb	21.9
¾ Wild	29.5 Ba	10.7 Bb	10.5 Bb	23.8 Ba	18.6
Mean	21.4	8.2	7.9	16.5	

¹CACAH = 'Cacahuacintle'; GT-FAWCC(C5) = Registered maize population; MpSWCB-4 = Registered maize population; P3369A = 'Pioneer 3369A'. Horizontal means followed by the same lowercase letter are not significantly different, and column means for each planting date followed by the same uppercase letter are not significantly different ($P \leq 0.05$) as separated by LSD (SAS Institute 1989).

The use of insects reared on artificial diet in the laboratory is critical to the development of an efficient and complete plant resistance research program (Davis & Guthrie 1992). However, once an insect colony has been established in the laboratory it becomes incumbent upon the researcher to monitor and maintain the quality of the colony. Quality control should be a system that incorporates feedback information from colonization effects, colony management, and field evaluation (Dickerson & Lep-

TABLE 7. EFFECT OF CORN LINES AND FALL ARMYWORM STRAIN ON LARVAL SURVIVAL AT 7 DAYS AFTER INFESTATION [WEIGHT(MG) OF LARVAE/5 PLANTS].

Insect Strain	Corn Line ¹				Mean
	CACAH	GT-FAWCC (C5)	MpSWCB-4	P3369A	
<i>Second Planting Date (29 May)</i>					
Check	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	0.0
Laboratory	124.3 Ca	31.2 Bb	39.0 Bb	101.3 Ca	75.5
¾ Wild	95.3 Ba	28.0 Bb	23.5 ABb	71.2 Ba	54.4
Mean	73.2	19.7	19.8	57.5	

¹CACAH = 'Cacahuacintle'; GT-FAWCC(C5) = Registered maize population; MpSWCB-4 = Registered maize population; P3369A = Pioneer 3369A. Horizontal means followed by the same lowercase letter are not significantly different, and column means followed by the same uppercase letter are not significantly different ($P \leq 0.05$) as separated by LSD (SAS Institute 1989).

TABLE 8. EFFECT OF CORN LINES AND FALL ARMYWORM STRAIN ON CORN DAMAGE (7-D VISUAL RATINGS).

Insect Strain	Corn Line ¹				Mean
	CACAH	GT-FAWCC (C5)	MpSWCB-4	P3369A	
<i>First Planting Date (13 May)</i>					
Check	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	0.0
Laboratory	4.3 Ba	3.2 Bb	2.3 Bc	5.0 Ba	3.7
¾ Wild	5.8 Ca	4.6 Cb	3.8 Cb	6.2 Ca	5.1
Mean	3.4	2.5	2.1	3.6	
<i>Second Planting Date (29 May)</i>					
Check	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	0.0
Laboratory	3.2 Bab	2.3 Bbc	1.5 Bc	3.8 Ca	2.7
¾ Wild	3.3 Ba	2.0 Bb	1.7 Bb	3.0 Ba	2.5
Mean	2.2	1.4	1.1	2.3	

¹CACAH = 'Cacahuacintle'; GT-FAWCC(C5) = Registered maize population; MpSWCB-4 = Registered maize population; P3369A = 'Pioneer 3369A'. Horizontal means followed by the same lowercase letter are not significantly different, and column means for each planting date followed by the same uppercase letter are not significantly different ($P \leq 0.05$) as separated by LSD (SAS Institute 1989).

TABLE 9. EFFECT OF CORN LINES AND FALL ARMYWORM STRAIN ON CORN DAMAGE (14-D VISUAL RATINGS).

Insect Strain	Corn Line ¹				Mean
	CACAH	GT-FAWCC (C5)	MpSWCB-4	P3369A	
<i>First Planting Date (13 May)</i>					
Check	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	0.0
Laboratory	8.2 Ba	4.8 Bb	4.5 Bb	8.8 Ba	6.6
¾ Wild	8.5 Ba	6.0 Cb	5.7 Cb	8.6 Ba	7.2
Mean	5.6	3.5	3.4	5.6	
<i>Second Planting Date (29 May)</i>					
Check	0.0 Aa	0.0 Aa	0.0 Aa	0.0 Aa	0.0
Laboratory	4.8 Ba	2.8 Bb	3.2 Bb	5.8 Ca	4.2
¾ Wild	4.7 Ba	2.5 Bb	3.0 Bb	4.5 Ba	3.7
Mean	3.2	1.8	2.1	3.4	

¹CACAH = 'Cacahuacintle'; GT-FAWCC(C5) = Registered maize population; MpSWCB-4 = Registered maize population; P3369A = 'Pioneer 3369A'. Horizontal means followed by the same lowercase letter are not significantly different, and column means for each planting date followed by the same uppercase letter are not significantly different ($P \leq 0.05$) as separated by LSD (SAS Institute 1989).

pla 1992). When the insect colony is no longer comparable to the wild population, researchers should consider strengthening the colony by the infusion of wild genes or replacing the colony with wild insects (Davis & Guthrie 1992). In deciding whether or not to strengthen an established laboratory colony, researchers should consider the goal of the proposed studies and the type of insect required to meet those research goals. Often, however, adequate research has not been conducted to guide the researcher in making these decisions.

Our studies indicate that research on plant resistance for the fall armyworm and the corn earworm would better predict the relative levels of resistance among different corn lines and among different silk diets if $\frac{3}{4}$ wild colonies were established annually, and if insects from these $\frac{3}{4}$ wild colonies were used in conducting laboratory and field bioassays. Caution should be exercised before discarding an established laboratory colony, however. Compared to a laboratory colony, a newly established $\frac{3}{4}$ wild strain may be less robust in laboratory culture and, therefore, less reliable in producing an adequate supply of insects for research purposes. Also, insect pathogens could be introduced into the colony even if the $\frac{3}{4}$ wild strain is established by introducing only males into the existing laboratory colony (Hamm et al. 1996).

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