Evaluation of Honduran landrace sorghums for antibiosis resistance to *Spodoptera frugiperda* (Lepidoptera: noctuidae)

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Abstract: Tropical landrace sorghum, *Sorghum bicolor* (L.) Moench, is mainly planted on small farms and intercropped with maize, *Zea mays* L. In Honduras, is damaged by insect pests, including the fall armyworm (FAW), *Spodoptera frugiperda*, (J. E. Smith). Some of these sorghums possess moderate levels of resistance against this pest. Four FAW feeding tests were conducted in the laboratory to evaluate several Honduran landrace sorghums for antibiosis resistance using whorl-leaf material collected daily from sorghum or a meridic diet. Tests began with neonate larvae from a laboratory colony originating on sorghum in southern Honduras. In the first test, FAW fed Paquete, Pompóm-170, Porvenir, and Catura-68 had longer larval plus pupal developmental times than FAW fed the susceptible Cacho de Chivo-169. However, no differences were observed in female pupal weight, fecundity, net reproductive rate (R_0), instantaneous rate of increase (r), and mortality between the native landrace cultivars and FAW resistant 'AF28' sorghum. In a second test, R_0 and r were lower for FAW fed Corona-195, Lerdo Ligero, and Norteño-72 than insects fed on 'AF28'. FAW fed on dw MC-36, a landrace sorghum, had lower pupal weight, fecundity, R_0, and r than insects fed 'AF28' in a third test. In a fourth test, FAW larvae fed DMV-143, Porvenir, and Gigante Pavana had lower r than insects fed on 'AF28' and Cacho de Chivo-169. The landrace sorghums exhibiting antibiosis resistance to FAW, where the fitness of the insect pest population is adversely affected, have utility in host plant resistance breeding programs. The inclusion of insect resistance traits into improved cultivars will enhance crop productivity. These cultivars will have utility where sorghum is intercropped with maize and where FAW is a serious constraint to crop production.

Keywords: *Sorghum bicolor*, fall armyworm, plant resistance.

Resumen: El sorgo nativo tropical, *Sorghum bicolor* (L.) Moench, es principalmente sembrado en pequeñas fincas e intercalado con maíz, *Zea mays* L. En Honduras es atacado y dañado por insectos plagas, incluyendo el gusano cogollero, *Spodoptera frugiperda*, (J.E. Smith). Algunos de estos sorgos poseen niveles moderados de resistencia contra estas plagas. Cuatro estudios sobre alimentación del cogollero fueron realizados en laboratorio para evaluar resistencia por antibiosis de las variedades nativas de sorgo hondureños, usando hoja de cogollo del sorgo colectada diariamente o en una dieta merídica. El estudio empezó con larvas recién nacidas provenientes de plantas de sorgo del sur de Honduras y criadas en el laboratorio. En el primer estudio, las larvas alimentadas con las variedades Paquete, Pompóm-170, Porvenir y Catura-68 tuvieron un tiempo de desarrollo larval y pupal más largo que las alimentadas con la variedad susceptible Cacho de Chivo-169. Sin embargo, no se observaron diferencias en pesos de pupas hembra, fecundidad, tasa neta reproductiva (R_0), capacidad intrínsica de crecimiento (r) y mortalidad entre los cultivares nativos y la variedad de sorgo 'AF-28' resistente a cogollero. En un segundo estudio, R_0 y r fueron más bajos en larvas alimentadas con Corona-195, Lerdo Ligero y Norteño-72 que las alimentadas con 'AF-28'. Los cogolleros alimentados con dw MC-36, un sorgo nativo, tuvieron menor peso pupal, fecundidad, R_0 y r que los alimentados con 'AF-28' en un tercer estudio. En el cuarto estudio, las larvas alimentadas con DMV-143, Porvenir y Gigante Pavana tuvieron r más bajo que las alimentadas con 'AF-28' y Cacho de Chivo-169. Los sorgos nativos con resistencia por antibiosis contra cogollero, donde las aptitudes de la población de insectos plagas es adversamente afectada, tienen utilidad en programas de mejoramiento por resistencia de las plantas hospederas. La inclusión de características de resistencia a insectos en cultivares mejorados, incrementaría la productividad de los cultivos. Estos cultivares podrán ser útiles donde el sorgo es intercalado con maíz y donde el cogollero es un serio problema para la producción.

Palabras claves: *Sorghum bicolor*, cogollero, plantas resistentes.

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INTRODUCTION

The fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith), is a constraint to sorghum, *Sorghum bicolor* (L.) Moench, and maize, *Zea mays* L., production in Honduras (Pitre 1987, Andrews 1988). Local farmers spend much needed money and time to control this pest throughout the crop growing season. They apply insecticides to control FAW on the crop without consideration of economic thresholds (Portillo *et al.* 1991). And, this pest is difficult to control because of its mobility as a cosmopolitan insect and because of its polyphagous feeding behavior (Luginbill 1928, Andrews 1988, Pitre 1987, Pashley 1988).

Little is known about sorghum resistance to insects. Teetes (1980) reported resistance due to non-preference and tolerance in sorghum to some insect and mite species. A sorghum hybrid with resistance to sorghum midge, *Contarinia sorghicola* (Coquillet), was identified by Teetes *et al.* (1986). This hybrid responded more to an insecticide treatment than susceptible hybrids with respect to net crop value. Reese (1981) and Dreyer *et al.* (1981) reported that the phenolics p-hydroxybenzaldehyde, dhurrin and procyanidin were present in resistant sorghum cultivars and deterred greenbug, *Schizaphis graminum* (Rondani), feeding. Sorghum cultivars with resistance to greenbug have a large amount of pectic fructan, a high molecular weight polysaccharide, that inhibits feeding (Dreyer *et al.* 1981). Phenolic acids have been implicated as a factor in the resistance of sorghum foliage to the migratory grasshopper, *Melanoplus sanguinipes* (Fabricius). In addition, tannin in sorghum acts as a feeding deterrent, but it does not affect insect development (Woodhead and Cooper 1979). Lara *et al.* (1980) reported antibiosis plant resistance to sorghum midge in 'AF28', a sorghum.

Most of the sorghum planted in Honduras are native landraces and are intercropped with maize (Hawkins 1984, Castro *et al.* 1989, Pitre 1987). This group of tropical landrace sorghum, colloquilly called "maicillo criollo", is widespread in Central America. The landrace sorghums are tall, photoperiod sensitive, and are adapted to intercropping systems, but do not have good agronomic characteristics (Meckenstock 1988, Castro *et al.* 1989).

Recently, Meckenstock *et al.* (1991) reported moderate levels of antibiosis resistance to FAW in landrace sorghums from southern Honduras. They indicated that this resistance in landrace populations appeared to be widespread and that the mechanism of resistance is associated with suppressing FAW population density increase through reduced fecundity. A hypothesis, based on differential selection and increased selection pressure brought about through intercropping with maize was presented to explain the development of this intermediate level of antibiosis in the landrace sorghum populations. However, very little is known about the mechanisms of host plant resistance in the large number of tropical landrace sorghums that are intercropped with maize in Honduras. This information would be of immense value in management of insect pests in low input intercropping systems.

The present study evaluated an additional number of Honduran landrace sorghums for antibiosis resistance to the FAW. The study was divided into four tests of different groups of sorghum because of limited laboratory and field space. Thus, the study was split in time and space, and each test is presented separately. This research represents the participation of the Secretaría de Recursos Naturales (SRN), the Escuela Agrícola Panamericana (EAP) and the USAID International Sorghum and Millet Collaborative Research Support Program (INTSORMIL).

MATERIALS AND METHODS

TEST 1. Five landrace sorghums selected from the National Sorghum Improvement Program in Honduras were evaluated for antibiosis to FAW in the laboratory at the Panamerican School of Agriculture, El Zamorano, Honduras. The landrace sorghums used were Pompóm-170, Paquete, Porvenir, Pelotón-99, and Catura-68. The sorghum variety 'AF28' (PI 383856), selected for antibiosis host plant resistance to FAW in studies in Brazil (Lara *et al.* 1980), was used as the resistant cultivar. 'AF28' has shown some level of resistance to natural infestations of FAW, having lower percentage of plants attacked and lower foliage feeding damage ratings. Cacho de Chivo-169 (caudatum durra, PI 536589), a landrace sorghum from Guatemala, was used as the susceptible check. In previous studies, Cacho de Chivo-169 was observed to be severely damaged by FAW (Meckenstock *et al.* 1991).

The sorghum cultivars were planted in the field on June 2, 1988 in a randomized complete block design (Steel and Torrie 1983). Seed treated with a commercial fungicide were planted by hand in 5 m rows, 80 cm apart and seedling plants were thinned to 10 cm between plants. The rainfall for the growth period from planting to bloom was 85.6 mm and the average temperature was 24 ± 6 C. Soil had pH 5.6, organic matter 1.7%, nitrogen 0.19%, phosphorous 13.3 ppm, and potassium 425 ppm. Commercially fertilizer (18-46-0, NPK) was applied in the furrow by hand at planting at the rate of 180 kg/ha and nitrogen (46% urea) was applied at the side of the plants at 52 kg/ha 30 days after planting (DAP).

Fresh leaf tissue was collected daily from sorghum plants beginning 34 DAP when plants were in the 8-10 leaf stage (Vanderlip 1972). The two youngest whorl leaves (newly formed leaves) were collected at random from the stock of food plants (plants growing in the field to serve as food) in the respective field treatment plots and used to feed the larvae until they pupated. The fresh leaves were cut and immediately wrapped in moist paper towels, bagged and transported to the laboratory. The leaves were disinfected with a 0.5% sodium hypochlorite solution for 5 min. and then rinsed in three washes of distilled water to kill any bacterial or fungal organisms on the leaf surface (Arabi *et al.* 1991, Sikorowski and Lawrence 1994) before being offered to the larvae. The leaves were placed in plastic cups (29.6 ml) containing 5 ml of agar to prevent desiccation of the leaves. Corncob grit (0.3 g) treated with 0.03% Griseoflavin, 0.04% phaltan, and 0.03% tetracycline was distributed over the solidified agar surface to prevent microorganism growth.

The FAW larvae used were collected on sorghum in southern Honduras and maintained on artificial diet (Burton and Perkins 1989) in the laboratory at 27 ± 2 C and photoperiod of 14:10 L:D. The insects used in the experiments were the second laboratory generation. Sufficient sorghum leaf material was collected from the field the same day it was offered to the larvae; the larvae had fresh material for feeding at all times during the test. One FAW egg mass was used per replication to reduce genetic variability among insects within replications. Sixty neonate larvae were randomly selected from individual egg masses and placed individually in the capped plastic cups for each treatment. Six larvae were included for each treatment in each of 10 replications. Cups of each treatment were placed in flats; flats with the different treatments in separate replications were stacked in blocks. Position of the treatment flats within each block was randomized.

The following observations were determined daily: percentage larval and pupal mortality, larval and pupal developmental times, generation time (larva plus pupa developmental time), female pupal weight (measured two days after pupation), fecundity, net reproductive rate, and instantaneous rate of increase.

Fecundity (F) was estimated using the formula reported by Leuck & Perkins (1972):

$F = 5.33wp - 423.23$,

where wp = female pupal weight (mg).

Net reproductive rate (R_o), a measure of the rate of increase of a population per generation, was calculated using fecundity and survivorship Birch (1948):

$R_o = F\,Lx$,

where $Lx = 1 - Pm$, with $Pm = Mortality/100$.

The instantaneous rate of increase (r) was estimated according to Birch (1948):

$r = [\log_e (R_o)]/\,T$,

where T = generation time (days).

The data were analyzed with ANOVA (Steel & Torrie 1983) using Proc GLM on SAS (SAS Institute' 1985), and where significant differences in variables were detected, means were separated using Duncan's multiple range test ($P \leq 0.05$) (Duncan 1955).

TEST 2. Five additional sorghum landraces including Angel de Limón, Lerdo Ligero, Variedad Blanca, Corona-195, and Norteño-72, were planted on July 8, 1988 and evaluated for antibiosis using the same procedures and analyses as in test 1. 'AF28' and Cacho de Chivo-169 were used as resistant and susceptible checks, respectively. The amount of rainfall for the period from planting to bloom was 67.7 mm and the average temperature was 24 ± 4 C. The feeding trial was initiated 30 days after sorghum planting when plants were at the 8-10 leaf stage. Laboratory conditions, parameters measured and analyses were as described in test 1.

TEST 3. The landrace sorghums used for antibiosis evaluation were San Bernardo III, Cola de Caballo-159, Paragüe, SC 1207-2-1-1 (partially converted line of San Bernardo III), and dw MC-36, plus the resistant AF-28 and the susceptible Cacho de Chivo-169. Cultivars were planted on September 18, 1988. The amount of rainfall from planting to bloom was 270 mm and the average temperature of 24 ± 3 C. The feeding study began 29 days after planting when plants were at the 8-10 leaf stage.

Laboratory conditions, parameters measured and statistical analyses were as described in test 1.

TEST 4. Eleven cultivars, including Cacho de Chivo-169 and 'AF28' were evaluated for antibiosis using a meridic diet technique. More accurate measurements of the amount of plant material offered to the insects are made when meridic diets are used than when fresh plant material is used to feed the larvae (Wiseman *et al.* 1984, Wiseman and Isenhour 1988). An artificial diet (Burton and Perkins 1989) was included for comparison. The cultivars used were DMV-143 (TAM428*San Bernardo III-23), DMV-179 [(SPV346*Gigante Pavana)-1-1-2 F_8], DMV-198 [(TAM428*Porvenir)-29-1 F_{10}], Gigante Pavana (caudatum-kafir, PI536567), Porvenir (caudatum-durra, PI536566), Tx430 (Tx2536*SC170-6), San Bernardo III (caudatum-durra, PI536581), SPV346 [zerazera, (SB1066*CS3541)-SU-53 sel.], and TAM428 (Zerazera, SC110-9 sel.). These cultivars were planted on June 18, 1990. The rainfall from planting to bloom was 17.3 mm and the average temperature was 23 ± 4 C.

The feeding trial began 34 days after planting when plants were in the 8-10 leaf stage. Leaves were collected as described previously and taken to the laboratory to be processed into a meridic diet form (Diawara *et al.* 1991). These procedures included washing the leaves with distilled water, grinding oven-dried leaves to a fine powder and incorporating the powder at a rate of 40 g/L into a modified pinto bean diet including water, pinto bean, torula yeast, agar, formaldehyde, ascorbic acid, methyl p-hydroxy benzoate, and sorbic acid (Burton and Perkins 1989). The meridic diet (5 ml) was dispensed into 29.6 ml cups.

Larvae were selected for use as described in test 1. Ten neonates were included for each treatment cultivar in each replication. Treatments were arranged in a randomized complete block design using eight replications. The cups with meridic diet were changed every two days until the larvae reached the pupal stage. Experimental procedures and analysis were as defined in the previous studies.

RESULTS AND DISCUSSION

TEST 1. FAW larvae fed Pompóm-170 had the shortest larval developmental time (14.7 ± 0.1 d, ± SE); whereas Porvenir and Catura-68 had the longest (15.3 ± 0.1 d) The mean larval plus pupal developmental time of FAW fed Porvenir, Pompóm-170, Paquete, and Catura-68 was significantly longer (0.4-0.5 d) than that for larvae fed the susceptible Cacho de Chivo-169 (Table 1). Delayed developmental time represents an expression of antibiosis resistance. Antibiosis host plant resistance has been defined as the negative effects caused by a resistant plant on the fitness of an insect following colonization of the plant; both chemical and morphological plant defenses mediate antibiosis (Painter 1951). The antibiosis effects may entail reduced fecundity, decreased size, abnormal length of life, and/or increased mortality.

There were no significant differences in female pupal weight, fecundity, net reproductive rate, instantaneous rate of increase, or larval plus pupal mortality among landrace sorghums and Cacho de Chivo-169, the susceptible check, and the resistant 'AF28' (Table 1). Nevertheless, as Birch (1948) reported, when population fitness is adversely affected, the instantaneous rate of increase of the population is reduced.

TEST 2. FAW fed Variedad Blanca, Corona-195, Lerdo Ligero, Angel de Limón, Norteño-72, the resistant cultivar 'AF28', and Cacho de Chivo-169, the susceptible cultivar, showed no significant differences in larval development or larval plus pupal developmental times (Table 2). On Lerdo Ligero, larvae required more than 30 days to complete larval and pupal development. Although the differences in larval plus pupal developmental times among cultivars were not significant, the data suggestst that there may be a reduction of FAW fitness by delaying the time to complete the life cycle on some sorghums. Female pupae varied in weight from 6.6 mg more to 43.8 mg less than pupae that developed on the susceptible Cacho de Chivo-169. FAW moths from heavier pupae might be expected to have higher fecundity than moths from pupae that weigh less (Leuck & Perkins 1972). Thus, adults emerging from pupae with lower than average weights may have fewer offspring than those emerging from heavier pupae. FAW that fed on Variedad Blanca had the lowest pupal weight and fecundity, followed in increasing order by Corona-195, Angel de Limón, Norteño-72, Cacho de Chivo-169 and Lerdo Ligero (Table 2).

The lowest net reproductive rates and instantaneous rates of increase were for FAW fed Corona-195, Variedad Blanco, Norteño-72 and Lerdo Ligero (Table 2). These rates were lower than that for FAW fed 'AF28'. FAW fed Cacho de Chivo-169, the susceptible cultivar, showed no difference in instantaneous rate of increase when compared with 'AF28'. This might suggest that Cacho de Chivo-169 may not be clearly identified as a susceptible landrace cultivar. The low instantaneous rates of increase can be related to low fecundity and low net reproductive rates, and low survival or higher mortality (Birch 1948).

Table 1. Mortality and developmental variables of fall armyworm, *Spodoptera frugiperda* (J. E. Smith), fed leaves of various sorghum cultivars. Test 1.

Cultivar	% larval + pupal mortality (Pm)	Mean developmental time,d Larva	(T) Larvae + pupa	Female pupal, wt (mg)	Fecundity (F)	Net reproductive rate (R_0)	Instantaneous rate of increase, d^{-1} (r)
Cacho de chivo-16[a]	37 ± 7	15.2 ± 0.2 ab	26.0 ± 0.0 b	211 ± 9	702 ± 38	445 ± 35	0.23 ± 0.02
Paquete	32 ± 8	14.9 ± 0.1 ab	26.4 ± 0.1 a	197 ± 6	628 ± 17	429 ± 44	0.23 ± 0.02
Pelotón-99	42 ± 7	15.2 ± 0.2 ab	26.2 ± 0.1 ab	203 ± 5	658 ± 24	384 ± 45	0.23 ± 0.02
Pompóm-170	43 ± 6	14.7 ± 0.1 b	26.4 ± 0.2 a	209 ± 6	689 ± 30	390 ± 41	0.23 ± 0.01
'AF28' [b]	42 ± 9	15.0 ± 0.2 ab	26.3 ± 0.1 ab	204 ± 6	665 ± 30	388 ± 37	0.22 ± 0.02
Porvenir	47 ± 5	15.3 ± 0.1 a	26.5 ± 0.1 a	203 ± 6	657 ± 38	351 ± 33	0.22 ± 0.02
Catura-68	48 ± 9	15.3 ± 0.1 a	26.4 ± 0.1 a	207 ± 4	680 ± 23	351 ± 38	0.22 ± 0.02
	NS			NS	NS	NS	NS

Means within a column (±SE) not followed by the same letter are significantly different at P≤0.05 level by Duncan's multiple range test (SAS Institute 1985). 60 larvae per cultivar, 26 ±2 C, photoperiod 14:10 L:D, NS=No significant difference.

[a] Moderately susceptible landrace cultivar

[b] Resistant cultivar

Table 2. Mortality and developmental variables of fall armyworm, *Spodoptera frugiperda* (J. E. Smith), fed leaves of various sorghum cultivars. Test 2.

Cultivar	% larval + pupal mortality (Pm)	Mean developmental time,d Larva	(T) Larvae + pupa	Female pupal, wt (mg)	Fecundity (F)	Net reproductive rate (R_0)	Instantaneous rate of increase, d^{-1} (r)
Angel de Limón	57 ± 6 b	13.4 ± 0.2	24.9 ± 0.2	144 ± 6 ab	344 ± 31 ab	149 ± 28 b	0.20 ± 0.01 a
Cacho de chivo- 169[a]	38 ± 8 b	16.0 ± 0.3	29.9 ± 0.2	180 ± 4 ab	537 ± 24 ab	331 ± 38 a	0.19 ± 0.01 a
Variedad Blanca	67 ± 3 b	13.5 ± 0.2	25.4± 0.3	136 ± 4 b	304 ± 21 b	102 ± 17 b	0.18 ± 0.01 a
'AF28' [b]	70 ± 1 a	17.0 ± 0.3	29.8 ± 0.2	178 ± 5 ab	525 ± 23 ab	160 ± 25 a	0.17 ± 0.01 a
Norteño-72	80 ± 5 a	14.9 ± 0.2	28.2± 0.2	154 ± 4 ab	399 ± 30 ab	78 ± 24 b	0.15 ± 0.00 b
Lerdo Ligero	82 ± 5 a	16.5 ± 0.3	31.3 ± 0.2	187 ± 4 a	572 ± 21 a	106 ± 17 b	0.15 ± 0.00 b
Corona- 195	85 ± 6 a	14.3 ± 0.3	26.9 ± 0.4	142 ± 6 ab	334 ± 38 ab	49 ± 25 b	0.14 ± 0.01 b
		NS	NS				

Means within a column (±SE) not followed by the same letter are significantly different at P≤0.05 level by Duncan's multiple range test (SAS Institute 1985). 60 larvae per cultivar, 26 ±2 C, photoperiod 14:10 L:D, NS=No significant difference.

[a] Moderately susceptible landrace cultivar

[b] Resistant cultivar

TEST 3. In this test larvae fed 'AF28' and Paragüe had the longest larval developmental times; larvae fed 'AF28' and San Bernardo III had the shortest larval plus pupal developmental times (Table 3). The low larval plus pupal developmental time for insects fed 'AF28' was inconsistent with the results of the first and second tests. Larvae fed the landrace dw MC-36 had the lowest pupal weight, fecundity, net reproductive rate, and instantaneous rate of increase; those fed Paragüe and SC 1207-2-1-1 also had low instantaneous rates of increase. These data suggest that fitness of FAW was negatively influenced by feeding on these cultivars (Birch 1948).

TEST 4. Fall armyworm required longer than 30 days to complete larval and pupal development when fed DMV-143, DMV-198, Gigante Pavana, and Porvenir, rather than 27.7 and 27.3 d when fed on 'AF28' and San Bernardo III, the resistant checks (Table 4). The lowest pupal weight and fecundity were observed with FAW fed DMV-143. Most of the other landraces, including Cacho de Chivo-169, were similar in fitness to 'AF28'. FAW fed the above four landrace sorghums exhibited lower instantaneous rates of increase than FAW fed the other test sorghums and the artificial diet (Table 4).

The low net reproductive rates and instantaneous rates of increase reported by Meckenstock et al. (1991) for FAW fed 'AF28' and San Bernardo III were not observed in test 4. This may be due to different environmental conditions for the two studies. Also, contamination of artificial diet by microorganisms was lower compared with fresh leaf material used in the other tests, and this may have contributed in part to the differences.

CONCLUSIONS

Honduran landrace sorghums appear to have various levels of antibiosis resistance to FAW larvae. The landrace sorghums generally exhibit intermediate resistance, having a negative influence on develomental times, pupal weight and fecundity. The low reproductive rate and instantenous rate of increase reflect the poor fitness of the population when the insects feed on sorghums with poor antibiosis resistance. This observation can have considerable impact on sorghum insect pest control, especially in areas such as southern Honduras, where the native landrace sorghums and improved sorghums (Meckenstock 1988) are grown on greater than 90% of the land used for production of this crop and where the FAW is a serious constraint to sorghum production.

Table 3. Mortality and developmental variables of fall armyworm, *Spodoptera frugiperda* (J. E. Smith), fed leaves of various sorghum cultivars. Test 3.

Cultivar	% larval + pupal mortality (Pm)	Mean developmental time, d: Larva	Mean developmental time, d: Larvae + pupa (T)	Female pupal, wt (mg)	Fecundity (F)	Net reproductive rate (R_o)	Instantaneous rate of increase, d^{-1} (r)
Cacho de chivo-169[a]	19 ±4 c	15.3 ±0.2 cd	25.0 ±0.1abc	178 ±4 b	525 ±4 b	426 ±12 a	0.24 ±0.01 a
Cola de Caballo	27 ±3 ab	14.9 ±0.1 d	24.8 ±0.3 bc	181 ±4 ab	543 ±5 ab	396 ±17 a	0.24 ±0.01 a
AF28 [b]	43 ±4 ab	16.4 ±0.3 ab	23.7 ±0.0 d	185 ±3 ab	562 ±9 ab	319 ±11 a	0.24 ±0.01 a
San Bernardo III	49 ±2 a	16.0 ±0.1 ab	24.3 ±0.1 cd	178 ±4 b	524 ±5 b	268 ± 8 b	0.23 ±0.00 ab
SC 1207-2-1-1 [c]	32 ±3 ab	15.9 ±0.3 bc	25.9 ±0.1 a	180 ±4 ab	538 ±4 b	367 ±13 a	0.23 ±0.00 ab
Paragüe	53 ±2 a	17.1 ±0.1 a	25.8 ±0.2 ab	191 ±3 a	595 ±9 a	278 ±14 b	0.22 ±0.01 b
dw MC-36	29 ±2 ab	16.5 ±0.1 cd	25.8 ±0.2 ab	152 ±4 c	384 ±9 c	274 ± 7 b	0.22 ±0.01 b

Means within a column (±SE) not followed by the same letter are significantly different at $P \leq 0.05$ level by Duncan's multiple range test (SAS Institute 1985). 60 larvae per cultivar, 26 ±2 C, photoperiod 14:10 L:D.

[a] Moderately susceptible landrace cultivar

[b] Resistant cultivar

[c] Partially converted line of San Bernardo III

FAW fed on some of the landrace sorghums, such as Porvenir, Paquete and Catura-68, had increased developmental times. The longer the time for development of the immatures, the greater the exposure of the insect to predation, parasitization, and insecticides. Therefore, such antibiosis characters are desirable in crop cultivars.

The favorable host plant resistance characteristics observed in some Honduran landrace sorghums in this study will be useful in the Honduran National Sorghum Breeding Program. Additional research, in which sources of antibiosis are combined, is a further objective to increase levels of insect resistance in sorghums for use in Honduras and elsewhere.

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Table 4. Mortality and developmental variables of fall armyworm, *Spodoptera frugiperda* (J. E. Smith), fed meridic diet containing leaf material (powder) of various sorghum cultivars. Test 4.

Cultivar	% larval + pupal mortality (Pm)	Mean developmental time, d: Larva	Larvae + pupa (T)	Female pupal, wt (mg)	Fecundity (F)	Net reproductive rate (R_o)	Instantaneous rate of increase, d^{-1} (r)
Artificial diet	13 ±2 e	16.8 ±0.4 cd	27.6 ±0.3 e	226 ±8 ab	779 ±41	682 ±10 a	0.236 ±0.00 a
San Bernardo III	48 ±5 bc	16.3 ±0.5 d	27.3 ±0.3 e	226 ±5 ab	781 ±27	410 ±11 bc	0.220 ±0.01 ab
SPV 346	44 ±5 cd	16.6 ±0.4 d	28.1 ±0.5 de	229 ±5 ab	798 ±28	449 ±13 b	0.217 ±0.01 ab
DMV -179	49 ±8 bc	16.9 ±0.6 cd	27.2 ±0.6 e	211 ±4 bc	699 ±22	358 ±15 bc	0.216 ±0.01 bc
'AF28' [a]	53 ±5 bc	16.8 ±0.5 cd	27.7 ±0.6 e	219 ±5 abc	741 ±26	352 ±12 bc	0.211 ±0.01 bc
Cacho de Chivo- 169[b]	31 ±6 d	17.6 ±0.9 cd	29.1 ±0.5 cde	207 ±4 bc	682 ±20	469 ±11 b	0.211 ±0.01 bc
Tx430	45 ±4 cd	17.4 ±0.6 cd	28.3 ±0.5 de	210 ±4 bc	696 ±19	383 ±10 bc	0.209 ±0.00 bc
TAM 428	55 ±4 b	15.9 ±0.1 d	27.8 ±0.3 de	220 ±5 abc	751 ±24	338 ±10 bc	0.209 ±0.00 bc
DMV - 198	48 ±7 bc	18.6 ±0.9 bc	30.0 ±0.9 bcd	202 ±4 c	651 ±20	342 ±13 bc	0.194 ±0.01 cd
Gigante Pavana	40 ±5 cd	19.8 ±0.5 ab	31.7 ±0.7 a	208 ±3 bc	684 ±18	410 ±11 bc	0.189 ±0.01 def
Porvenir	54 ±5 bc	21.3 ±1.2 a	31.6 ±1.1 a	201 ±4 c	647 ±19	299 ±11 c	0.180 ±0.01 ef
DMV - 143	65 ±7 a	19.8 ±0.6 ab	30.6 ±0.3 bc	200 ±7 c	641 ±28	224 ±16 c	0.177 ±0.00 f

Means within a column (±SE) not followed by the same letter are significantly different at $P \leq 0.05$ level by Duncan's multiple range test (SAS Institute 1985). 80 larvae per cultivar, 26 ±2 C, photoperiod 14:10 L:D.

[a] Resistant cultivar

[b] Moderately susceptible landrace cultivar

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