A Field Test of Corn Cultivars for Insect and Disease Resistance[1]

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ABSTRACT

Eighteen corn cultivars were tested for resistance to three corn pests (corn earworm, sugarcane borer, and corn silk maggot), and two diseases (corn rust and corn blight) at Mayagüez, Puerto Rico. Armyworm control with methomyl was necessary to produce a corn crop. Eighteen cultivars from Georgia were less resistant to pests and diseases than Mayorbela, Ibadan A, and Ibadan B. Significant differences were found between sprayed and unsprayed plots in yield and pest infestation.

INTRODUCTION

Corn (*Zea mays L.*) production in Puerto Rico is severely limited by insects and diseases. Chemical control of the yellowstriped armyworm, *Spodoptera ornithogalli* (Guenée), is usually required if the crop is to survive the first few weeks. The sugarcane borer, *Diatraea saccharalis* (F.), tunnels in the stems and is a serious pest in sensitive varieties of corn. Corn earworm [*Heliothis zea* (Boddie)] damages ears and may reduce grain yields. The corn silk maggot (*Euxesta stimatias* Loew) damages ears, particularly in the breeding nursery where ears are covered with paper bags. In addition to the insect pests described above, rust (*Puccinia polysora* Underw) and blight, mostly *Bipolaris maydis* (Nisikado) Shoemaker, are important factors causing yield reduction.

Previous work by Quintana and Walker[3, 4, 5] showed considerable variation in resistance to the sugarcane borer among different species of Gramineae and different varieties of corn.

The objective of this trial was to evaluate resistance to earworm damage among a group of corn cultivars. For the test plants to survive

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[3] Quintana-Muñiz, V., and Walker, D. W., Oviposition preference by gravid sugarcane borer moths in Puerto Rico, J. Econ. Entomol. 63(3): 987–88, 1970a.

[4] Quintana-Muñiz, V., and Walker, D. W., Host-plant choice in the laboratory of first-stage sugarcane borers in Puerto Rico, J. Econ. Entomol. 63(3): 988–89, 1970b.

[5] Quintana-Muñiz, V., and Walker, D. W., Survival and maturation in the laboratory of third-stage sugarcane borer in different host plants in Puerto Rico, J. Econ. Entomol. 63(3): 989–90, 1970c.

beyond the seedling stage, however, chemical control of armyworm was necessary.

MATERIALS AND METHODS

VARIETIES

Eighteen cultivars were evaluated in this test (table 1). Fifteen cultivars, reportedly tolerant to corn earworm, were selected and seed was provided by the Southern Grain Insect Research Laboratory, Georgia Coastal Plain Experiment Station, Tifton, Georgia. The three other cultivars tested were Mayorbela, a local cultivar with considerable tolerance to insects and diseases, and Ibadan A and Ibadan B, two broadbased corn populations initially synthesized by the Federal Department of Agricultural Research, Ibadan, Nigeria, West Africa. Ibadan A was derived predominantly from Colombia and U. S. Corn Belt germplasm, and has been released as PR-Mpl. Ibadan B was developed from predominantly Caribbean germplasm and has been released as PR-MO_4.

CULTURAL PRACTICES

The trial was planted in the Isabela farm of Mayagüez Institute of Tropical Agriculture on April 24, 1971. Each plot consisted of two rows, 3.6 m long, spaced 1 m apart. Ten hills were planted in each row with three seeds dropped in the end hills and two in all other hills. After emergence, the end hills were thinned to two plants and all other hills were thinned to one plant, providing 24 plants/plot. Plots were arranged in randomized blocks with 10 replications.

A fertilizer mixture was applied preplant in the row at a rate of 824 kg/ha. It was a mixture of 6 parts triple superphosphate, 5 parts ammonium sulfate, and 5 parts 12-8-10. Ammonium sulfate was also applied as a side-dressing on May 19 at 560 kg/ha. The plant leaves were sprayed to run-off with $ZnSO_4$, 45 gm/8.5 l of water on May 19 to correct a zinc deficiency situation.

The initial infestation of armyworms was controlled in all plots by spraying with Diazinon[6] [*O,O*-diethyl *O*-(2-isopropyl-6-methyl-4 pyrimidinyl) phosphorothioate] on May 12 at a rate of 50 cm^3/8.5 l of water applied at 146 l/ha, and on May 15 and 18 with 5 g of methomyl (S-methyl *N*-[(methylcarbamoyl) oxy] thioacetamidate)/51 l of water at 146 l per ha. A system of weekly spraying with methomyl to control insects on only half of the plots (odd-numbered replicates) was begun on May 25

[6] Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico or an endorsement over other equipment or materials not mentioned.

and ended July 12. All spraying was done by hand. The plots in even-numbered replicates were left unsprayed after May 18 so that natural pest infestation might occur in all cultivars except where genetic plant resistance might prevent it. Yield differences between sprayed and unsprayed plots within cultivars were expected to measure the degree of natural genetic resistance to insect infestation.

The ears from each plot were harvested on August 1 and 2, and then counted and evaluated for earworm damage. Small ears (nubbins), 12.5 cm or less, were noted and reported as a percentage of the total ears. Following harvest, 83% of the stalks were split and examined for larvae of sugarcane borers and other stalk-boring insects. The statistical analysis was made by the Statistical Laboratory, Iowa State University, Ames.

RESULTS AND DISCUSSION

Plant stands were nearly perfect after thinning. Spraying with $ZnSO_4$ had corrected Zn deficiency symptoms.

The agronomic performance data of each cultivar is shown in table 1. The trial measured the effective tolerance of the cultivars against earworms, stem borers, rust, blight, and armyworms. Spraying resulted in good control of armyworms, but not of earworms. Apparently, weekly spraying was not enough. Of the 15 cultivars from Georgia only 10L 70DDRM was as tolerant to earworms as Mayorbela and Ibadan A. Husks covered ears equally well in all entries, so it may be assumed that tolerance was physiological in nature.

Grain yield, among other factors, is a function of length and number of ears, both of which are under genetic control. However, in this trial, size of ear was also influenced by environment. The most productive cultivars had the largest and highest number of ears per plant. Ear size was influenced by armyworms, which shredded the margins of the leaves of the plants in unsprayed plots, and by blight. In most comparisons, sprayed plots contained plants with longer ears than did unsprayed plots.

Highest yielding varieties were the most tolerant to rust and blight. Because rust develops late in the life of the plant, it was assumed that blight limited corn production more than did rust. Mayorbela, a local cultivar, has acquired good tolerance to pests and diseases by the process of natural selection. Ibadan A and Ibadan B are heterogeneous unselected populations, and on the average the plants are less tolerant to rust than are plants of Mayorbela. Good tolerance can be achieved by selection.

Lodging was observed to be of two types, stalk (plants break below the ear) and root (plants lean at an angle of 45° or more). Most of the lodging

TABLE 1.—*Performance of corn cultivars grown at Isabela, Puerto Rico, relative to resistance to selected diseases and insects and effectiveness of selected chemical controls, 1972*

Entry	Treatment[1]	Planting to tassel	Height		Disease scores[2]		Insect scores[3]		Lodging	Ears/ stalk	Nubbins[4]	Yield[5]
			Ear	Plant	Rust	Blight	Army-worms	Ear-worms				
		Days	*Cm*						%	*No.*	%	*Q/ha*
Mayorbela	S	52	120	260	1	1	1	1	1.6	1.18	15	43.0
	U	50	102	255	1	1	2	1	17.0	1.08	16	35.2
Av.	—	—	—	—	—	—	—	—	—	—	—	39.1* a
Ibadan A	S	53	135	260	2	1	1	1	2.4	.99	21	39.7
	U	54	120	250	2	1	2	1	3.3	1.02	28	31.9
Av.	—	—	—	—	—	—	—	—	—	—	—	35.8* ab
Ibadan B	S	52	120	260	2	1	1	3	3.4	1.08	23	35.8
	U	51	125	260	2	1	3	2	6.8	1.04	26	31.6
Av.	—	—	—	—	—	—	—	—	—	—	—	33.7 b
SC CBT	S	53	115	260	3	1	1	2	1.6	1.04	32	38.5
	U	55	115	250	3	2	3	2	7.9	.76	38	24.1
Av.	—	—	—	—	—	—	—	—	—	—	—	31.3* bc
RFC RM-1	S	52	115	260	3	2	1	2	8.5	1.00	27	30.9
	U	50	120	260	3	2	2	1	12.0	1.03	25	27.2
Av.	—	—	—	—	—	—	—	—	—	—	—	29.0 bcd
Antigua	S	57	100	240	2	1	1	3	22.6	1.14	31	22.5
2D-118	U	55	110	240	2	2	2	2	33.0	1.29	19	29.4
Av.	—	—	—	—	—	—	—	—	—	—	—	26.0* de
RFC RM-1	S	52	100	245	3	2	1	2	13.0	.93	32	21.0
	U	52	105	245	3	3	2	2	3.6	.82	25	22.0
Av.	—	—	—	—	—	—	—	—	—	—	—	21.5 ef
GT-EEW	S	51	110	260	3	3	1	1	10.5	.84	34	21.9
RS-8	U	53	95	240	4	3	3	2	6.3	.76	47	13.3
Av.	—	—	—	—	—	—	—	—	—	—	—	17.6* fg
DD SI	S	55	110	240	3	2	1	2	3.3	.95	44	19.6
Rec.	U	54	95	230	3	3	4	2	10.3	.80	47	12.0
Av.	—	—	—	—	—	—	—	—	—	—	—	15.8* gh

Z Chico	S	43	80	200	2	3	1	2	9.4	.97	45	15.3
2451	U	41	80	200	2	3	3	2	12.2	.71	53	12.9
Av.	–	–	–	–	–	–	–	–	–	–	–	14.1 ghi
10 L 70	S	55	100	250	4	3	1	1	1.7	.79	34	18.2
DDRM	U	54	95	225	4	3	4	1	8.4	.71	40	9.8
Av.	–	–	–	–	–	–	–	–	–	–	–	14.0* ghi
Syn B	S	49	100	230	4	3	1	5	4.1	.81	39	17.7
	U	49	100	225	4	3	4	6	7.1	.74	48	9.2
Av.	–	–	–	–	–	–	–	–	–	–	–	13.4* ghi
SC	S	54	100	250	4	3	1	2	4.0	.71	60	14.6
Composite	U	50	95	230	3	2	4	3	7.6	.72	75	9.8
Av.	–	–	–	–	–	–	–	–	–	–	–	12.2* hi
CB 65	S	52	95	240	3	3	1	2	6.9	.80	63	15.6
	U	53	90	230	3	3	4	4	16.7	.60	89	7.4
Av.	–	–	–	–	–	–	–	–	–	–	–	11.5* hi
SA 65A	S	58	110	250	3	2	1	2	4.3	.73	50	14.9
	U	55	115	245	3	3	4	2	13.7	.53	68	7.6
Av.	–	–	–	–	–	–	–	–	–	–	–	11.3* hi
SA 65B	S	58	115	250	3	2	1	2	4.4	.64	57	11.8
	U	56	115	250	3	3	4	2	13.8	.61	80	8.1
Av.	–	–	–	–	–	–	–	–	–	–	–	10.0 i
Syn A	S	50	100	240	4	3	1	4	2.4	.69	48	13.8
	U	49	90	230	3	3	4	4	10.4	.66	92	5.7
Av.	–	–	–	–	–	–	–	–	–	–	–	9.8* i
CA 65	S	55	100	250	3	3	1	3	9.0	.56	56	12.9
	U	53	95	240	3	3	4	3	10.0	.39	90	6.5
Av.	–	–	–	–	–	–	–	–	–	–	–	9.7 i

[1] S = sprayed plots and U = unsprayed plots.

[2] Scores for rust and blight: 1–2 = degrees of resistance and 4–5 = degrees of susceptibility.

[3] Scores for Southern armyworm: 1 = no damage and 5 = severe damage. Scores for earworm: 1 = 5% ear damage, 2 = 10% ear damage, 3 = 15% ear damage, 4 = 20% ear damage, 5 = 30% ear damage and 6 = >30% ear damage.

[4] Nubbins = ear 12 cm or less.

[5] * indicates significance between means of sprayed and unsprayed plots at 0.05 significance level (LSD .05: 6.4). Means followed by the same letter or letters do not differ significantly at the 0.05 level.

TABLE 2.—*Infestation of stalks of corn cultivars by sugarcane borers and other insects at Isabela, Puerto Rico in 1972*

Entry	Sugarcane borers, % stalks infected[1]			Sugarcane borers, Av. number/stalk[2]			Other insects, % stalk infected[3]		
	Sprayed	Unsprayed	$\bar{x}$	Sprayed	Unsprayed	$\bar{x}$	Sprayed	Unsprayed	$\bar{x}$
Ibadan A	66	88	77	5.1	5.9	5.5a	22	13	18
SC CBT	64	51	58	3.3	7.1	5.2ab	9	52	31
DD Sel Rec	53	80	67	3.4	5.3	4.4abc	12	8	10
RFC RM-1 D-1	71	60	66	4.8	3.3	4.1abcd	10	3	7
SA 65B	46	73	60	3.9	4.3	4.1abcd	18	8	13
Ibadan B	64	72	68	2.3	5.6	4.0abcde	8	6	7
Mayorbela	60	86	73	3.2	4.5	3.9abcde	25	18	22
SC Composite	53	68	61	2.3	5.3	3.8abcde	8	10	9
Syn A	50	64	57	4.4	3.0	3.7abcde	9	11	10
RFC RM-1	55	77	66	2.7	4.4	3.6abcde	7	5	6
SA 65A	53	88	71	1.7	5.0	3.3bcde	16	20	18
10 L 70 DDRM	50	71	61	3.4	2.8	3.1cde	4	11	8
Antigua 2D-118	59	61	60	2.1	3.7	2.9cde	4	13	9
CB 65	61	65	63	2.2	3.0	2.6cde	17	2	9
Syn B	42	71	57	2.2	2.7	2.5cde	4	12	8
GT EEW RS-8	54	70	62	2.4	2.4	2.4de	13	20	17
Z Chico 2451	40	68	54	1.5	3.1	2.3de	2	11	7
CA 65	55	58	57	2.3	1.8	2.1e	9	15	12
Av.	55	70	63	2.9	4.5	3.5	11	13	12

[1] Differences between sprayed and unsprayed plots significant at 0.01 level. Differences between varieties not significant.

[2] Means followed by the same letter or letters do not differ significantly at the 0.05 level.

[3] Differences between treatments or varieties not significant.

was of the root type. The cultivar Antigua began to root lodge before tasseling, preventing proper application of the last few sprays. Antigua is of Caribbean origin and has moderate tolerance to insects and diseases.

Stalk breaking may also be due to the presence of stem borers (table 2). Such a high percentage of stalks was infested with borers that it is surprising there was not more stalk breakage. The corn stalk appears to be able to tolerate a number of borers because the most productive varieties had the highest percentage of infested stalks and the highest number of borers per stalk.

Spraying significantly reduced the percentage of plants with borers, but differences among cultivars were not significant. There were significant differences among cultivars with respect to number of borers per plant.

Armyworm control in corn seedlings is essential for successful corn production in Puerto Rico. If armyworms are controlled in the seedling stage, productive corn cultivars can be selected which have good tolerance to the other insects and diseases of the island. Such varieties may be used to produce a commercial crop or serve as a germplasm pool in breeding programs. Cultivars from Georgia were not equal to those originating in the Caribbean for tolerance to earworms.

RESUMEN

Se probaron 18 cultivares de maíz para determinar su resistencia al ataque de tres plagas, (gusano de la mazorca, taladrador del tallo de la caña y gusanos de la barba de la mazorca) y a dos enfermedades (roya y tizón). Quince cultivares introducidos de Georgia demostraron menos resistencia a las plagas y a las enfermedades que el Mayorbela, Ibadan A e Ibadan B, que son originarios del Caribe. Se observó una diferencia significativa en la producción y en la razón de infestación de las plagas, pero no de enfermedades, entre las parcelas asperjadas y las no asperjadas. La producción mayor está aparentemente relacionada con la resistencia a las enfermedades. Es necesario controlar el gusano cogollero para obtener buenos rendimientos. Aspersiones semanales de "methanyl" controlaron el gusano cogollero, pero no el de la mazorca.