

Productivity of new sugarcane hybrids in the Lajas Valley and their resistance to smut and rust¹

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ABSTRACT

Seventeen promising new sugarcane hybrids and three check varieties were planted in the Lajas valley, a semi-arid and irrigated area of southwestern Puerto Rico. Plant cane and ratoon crops were evaluated for yield and resistance to smut (*Ustilago scitaminea* Syd.) and rust (*Puccinia melanocephala* H. Syd. & P. Syd.). All new hybrids tested were resistant and tolerant to smut and rust. The smut incidence on susceptible check increased after ratooning. However, rust resistance and susceptibility of sugarcane hybrids and check varieties remained unchanged throughout a three-crop cycle. Combined analysis of variance of 2 years (plant and first ratoon crops) indicated that yields (sugar ton/ha) of five hybrids were consistently higher than those of the other genotypes tested, including the standard check variety PR 980.

RESUMEN

Productividad de nuevos híbridos de caña de azúcar en el valle de Lajas y su resistencia al carbón y a la roya

En el valle semiárido de Lajas, en el suroeste de Puerto Rico, se sembraron con riego 17 nuevos híbridos de caña de azúcar para evaluar su rendimiento y resistencia al carbón (*Ustilago scitaminea* Syd.) y a la roya (*Puccinia melanocephala* H. Syd. & P. Syd.) en las etapas de plantilla y retoños. Todos los nuevos híbridos mostraron resistencia y tolerancia a estas enfermedades. La incidencia del carbón aumentó en el testigo susceptible cuando se dejó retoñar; sin embargo, la resistencia y susceptibilidad de los híbridos y variedades testigo a la roya se mantuvieron inalteradas durante los 3 años de siembra. El análisis de varianza combinado de 2 años (plantilla y primer retoño) indicó que la producción de 5 híbridos fue consistente y más alta que la de los demás genotipos, incluyendo la variedad testigo PR 980.

INTRODUCTION

Sugarcane production in Puerto Rico has declined drastically in the last 20 years from almost 6,000,000 tons in 1969 to 1,216,000 tons in 1989,

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an 80% reduction. However, in economic importance sugarcane is the third crop after coffee and plantain in the island. In 1989 it contributed about \$25 million to our gross income (1, 9).

Acreage of cane harvested is estimated at 20,000 ha. Yield is about 61 tons per ha. The smut-susceptible variety PR980 occupies 22% of the sugarcane acreage in Puerto Rico. Fortunately, it has been gradually replaced by new varieties highly resistant to smut and rust, with good yield and performance in south and southeastern Puerto Rico.

Among 85 sugarcane diseases reported in the world (8), smut (*Ustilago scitaminea* Syd.) and rust (*Puccinia melanocephala* H. Syd. & P. Syd.) are now widely distributed in Puerto Rico (5, 6). A factor for the rapid dissemination of both diseases has been the use of susceptible varieties. A group of promising sugarcane hybrids of the AES-UPR cane breeding program have been tested in different ecological and sugarcane producing areas in the island with good performance in plant cane and ratoon crops. The objective of the research was to evaluate 17 hybrids for productivity and resistance to smut and rust in a semi-arid and irrigated area of Puerto Rico.

MATERIALS AND METHODS

Field tests were conducted at the Lajas Substation in southwestern Puerto Rico from April 1987 to January 1990. The soil is a Vertisol with a pH of 7.3. Seventeen promising sugarcane hybrids from the AES-UPR cane breeding program and three check varieties were planted in four replicated field plots. A partially balanced incomplete block design was used. Plot size consisted of 4 rows 1.52 m apart and 3.05 m long.

Smut- and rust-susceptible varieties PR 80-1052 and PR 67-3129 were used. PR 980 was the standard check. Hybrids and checks were monitored for smut and rust symptoms during the course of plant cane and two ratoon crops. The scales used for smut monitoring in Hawaii (10) and for rust in Florida (12) were modified slightly for the present evaluations. In both numerical scales, the values 0 to 1 denote highest resistance, and the value 9 denotes highest susceptibility. Hybrids and checks were rated at tillering (4 to 5 months of age) and at pre-maturity stages of growth (8-10 months of age). Rust severity was observed basipetally from the top visible dewlap (TVD) leaf (7). An analysis of variance was performed for data on cane tonnage, sugar content, and sugar yields per ha for each test. A combined analysis of variance for plant and first ratoon crops was also made. Planting, irrigation, cultivation, fertilization, and weeding followed the general practice of this area.

RESULTS AND DISCUSSION

Table 1 shows data on sucrose content, tons of cane, and tons of sugar per ha for the plant cane crop. As to total sugar of the plant cane crop

TABLE 1.—*Plant cane crop mean yields of the 17 best performing sugarcane hybrids and checks at the Lajas Substation*

Rank	Variety	Sucrose content (%)	TC/ha ¹	TS/ha ²
1	PR 76-1006	7.13	19.3	1.36 a ³
2	PR 78-294	9.86	12.6	1.26 ab
3	PR 80-1096	9.04	13.2	1.20 abc
4	PR 78-401	10.41	11.8	1.16 abc
5	PR 75-138	10.85	10.6	1.16 abc
6	PR 76-19	7.72	14.8	1.15 abcd
7	PR 76-2052	8.41	13.5	1.13 abcd
8	PR 80-1002	8.53	13.1	1.12 abcd
9	PR 81-1004	9.25	11.0	1.03 abcd
10	PR 67-3129 ⁴	10.72	9.1	0.97 abcd
11	PR 67-1355	7.86	12.1	0.96 abcd
12	PR 80-1079	7.03	12.9	0.91 bcd
13	PR 78-257	9.68	9.2	0.89 bcd
14	PR 76-3132	9.06	9.8	0.88 bcd
15	PR 70-2056	7.77	10.8	0.85 bcd
16	PR 80-1081	6.78	12.5	0.85 bcd
17	PR 76-2024	8.43	9.5	0.79 d
18	PR - 980 ⁵	6.11	10.1	0.79 d
19	PR 80- 1052 ⁶	7.68	10.1	0.79 d
20	PR 67-1070	9.37	7.8	0.75 d
	\bar{X}	8.58	11.4	1.00
	C.V. (%)	13.23	15.9	21.88

¹Tons of cane per ha.

²Tons of sugar per ha.

³Values in column followed by the same letter do not differ significantly at the 5% probability level.

⁴Rust susceptible check.

⁵Standard check.

⁶Smut susceptible check.

calculated on the basis of sucrose content and tonnage of cane, PR 76-1006 was the leading hybrid followed by the other 10 genotypes, including the rust susceptible check PR 67-3129 and PR 67-1355, but there were no significant differences among them (table 1). Results from the first ratoon crop (table 2) indicate that tonnage of cane (18.9 vs 11.4) and sugar (1.95 vs 1.00) per ha were higher than those obtained in plant cane. The percentage of sucrose was also higher (10.2 vs 8.6). Presumably, yields were affected by prolonged rainfall during the plant cane harvest (83 mm vs 14 mm in the first ratoon harvest). No significant differences were observed in tons of sugar per ha among the first 15 genotypes. However, the yields of PR-1006, PR 78-294, and PR 75-138 were higher than those of the standard check PR 980. In spite of the fact that the sucrose content of PR 76-1006 was lower than that of the mean value of the first ratoon test (9.9 vs 10.2), the tonnage of cane per ha and con-

TABLE 2.—*Frist ratoon crop mean yields of the 17 best performing sugarcane hybrids and checks at the Lajas Substation*

Rank	Variety	Sucrose content (%)	TC/ha ¹	TS/ha ²
1	PR 76-1006	9.90	28.9	2.90 a ³
2	PR 78-294	12.58	21.2	2.81 a
3	PR 75-138	9.954	25.1	2.51 ab
4	PR - 980 ⁴	9.77	25.3	2.47 abc
5	PR 78-401	10.72	20.2	2.16 abcd
6	PR 80-1096	11.79	18.2	2.15 abcd
7	PR 80-1081	10.40	20.3	2.14 abcd
8	PR 67-1355	11.13	20.6	2.10 abcd
9	PR 81-1004	9.94	20.0	2.04 abcd
10	PR 76-19	9.31	22.6	2.02 abcd
11	PR 78-257	9.26	20.0	1.97 abcd
12	PR 80-1029	9.84	19.6	1.91 abcd
13	PR 78-2024	10.44	18.9	1.84 abcd
14	PR 70-2056	11.62	15.3	1.83 abcd
15	PR 67- 3129 ⁵	10.64	16.3	1.73 abcd
16	PR 80-1079	8.47	16.6	1.55 bcd
17	PR 76-3132	10.82	11.6	1.30 bcd
18	PR 76-2052	9.33	12.2	1.30 bcd
19	PR 80- 1052 ⁶	7.42	15.5	1.27 cd
20	PR 67-1070	10.74	9.9	1.04 d
	\bar{X}	10.20	18.9	1.95
	C.V. (%)	13.15	31.7	33.29

¹Tons of cane per ha.

²Tons of sugar per ha.

³Values in column followed by the same letter do not differ significantly at the 5% probability level.

⁴Standard check.

⁵Rust susceptible check check.

⁶Smut susceptible check.

sequently the tons of sugar per ha were the highest among the 20 genotypes tested (table 2).

The combined analysis of variance from plant cane and first ratoon crops indicates that PR 76-1006, PR 78-294, PR 75-138, PR 80-1096, and PR 78-401 continue to be consistently good yielders (table 3). The sweet hybrid PR 67-1070 produced the lowest yields (tonnages of cane and sugar) among the 20 genotypes tested. It appears that this hybrid could not adapt well in the heavy soils with the poor drainage conditions of the Lajas valley. Chu and Rodríguez (3) reported that PR 67-1070 was better adapted to humid or irrigated areas in light soils with good drainage. In spite of the fact that the acreage of the hybrid PR 67-1355 has been expanded in the last 5 years, its yields obtained in two cycles were lower than those of PR 980 (table 3).

TABLE 3.—*Plant cane and first ratoon mean yields of the 17 best performing sugarcane hybrids and checks at the Lajas Substation*

Rank	Variety	Sucrose content (%)	TC/ha ¹	TS/ha ²
1	PR 76-1006	8.50	24.1	2.13 a ³
2	PR 78-294	11.20	17.0	2.03 ab
3	PR 75-138	10.40	17.8	1.83 abc
4	PR 80-1096	10.43	15.7	1.69 abcd
5	PR 78-401	10.82	15.3	1.63 abcd
6	980 ⁴	7.94	19.5	1.63 abcd
7	PR 76-19	8.52	18.7	1.59 abcde
8	PR 67-1355	9.48	16.4	1.53 abcde
9	PR 81-1004	9.58	15.5	1.52 abcde
10	PR 80-1002	9.47	16.3	1.49 abcde
11	PR 80-1081	8.60	16.3	1.49 abcde
12	PR 78-257	9.47	14.6	1.43 bcde
13	PR 78-2024	9.18	14.9	1.36 bcde
14	PR 67-3129 ⁵	10.70	12.7	1.36 bcde
15	PR 70-2056	9.69	13.1	1.34 bcde
16	PR 80-1079	7.75	14.7	1.23 cde
17	PR 76-2052	8.88	12.8	1.21 cde
18	PR 76-3132	9.93	10.6	1.08 de
19	PR 80-1052 ⁶	7.56	12.9	1.04 de
20	PR 67-1070	10.05	8.9	0.89 e
	\bar{X}	9.39	15.4	1.48
	C. V. (%)	9.50	22.7	25.22

¹Tons of cane per ha.

²Tons of sugar per ha.

³Values in column followed by the same letter do not differ significantly at the 5% probability level.

⁴Standard check.

⁵Rust susceptible check.

⁶Smut susceptible check.

Yield data reported in this paper indicate that new hybrids, which performed well in other ecological areas of Puerto Rico, are poor producers when grown under conditions prevailing in the Lajas valley regardless of adequate irrigation.

Rust disease incidence was similar to that observed in plant cane and first ratoon crop. Although rust and smut incidence was relatively lower throughout three tests, the rust and smut susceptible references revealed the highest infection during the cycle crops (table 4). The smut infection of PR 80-1002, PR 76-19, the smut check PR 80-1052, and the standard check PR 980 increased after ratooning (table 4). Similar results have been reported recently in Puerto Rico (5, 6). The smut infection did not change the sugar content of the smut susceptible check for PR-80-1052 (tables 1, 2). It has not been reported that smut is causing overall

TABLE 4.—Reaction of 17 performing sugarcane hybrids and checks to smut (*Ustilago scitaminea*) and rust (*Puccinia melanocephala*) at the Lajas Substation

Variety	Plant Cane				First Ratoon				Second Ratoon			
	Smut ¹		Rust ²		Smut		Rust		Smut		Rust	
	G	Rn	G	Rn	G	Rn	G	Rn	G	Rn	G	Rn
PR 76-1006	1	R	0	R	1	R	0	R	1	R	0	R
PR 78-294	1	R	0	R	1	R	0	R	1	R	0	R
PR 75-138	1	R	0	R	1	R	0	R	1	R	0	R
PR 78-1096	1	R	2	R	1	R	3	R	1	R	0	R
PR 78-401	1	R	0	R	2	T	0	R	2	T	0	R
PR 980 ³	4	T	0	R	6	S	0	R	4	T	0	R
PR 76-19	1	R	1	R	2	T	1	R	1	R	0	R
PR 67-1355	1	R	1	R	1	R	4	R	1	R	0	R
PR 81-1004	1	R	1	R	1	R	5	T	1	R	0	R
PR 80-1002	3	T	0	R	3	T	0	R	2	T	0	R
PR 80-1081	1	R	2	R	1	R	0	R	1	R	1	R
PR 78-257	1	R	0	R	1	R	2	R	1	R	0	R
PR 78-2024	1	R	1	R	1	R	1	R	1	R	0	R
PR 67-3129 ⁴	1	R	7	S	1	R	8	S	1	R	7	S
PR 70-2056	1	R	0	R	1	R	0	R	1	R	0	R
PR 80-1079	1	R	0	R	1	R	1	R	1	R	0	R
PR 76-2052	1	R	1	R	1	R	3	R	1	R	0	R
PR 76-3132	1	R	0	R	1	R	0	R	1	R	0	R
PR 80-1052 ⁵	6	S	0	R	8	S	0	R	7	S	2	R
PR 67-1070	1	R	0	R	1	R	0	R	1	R	0	R
\bar{X}		1.5	0.8		1.8	1.4			1.6	0.5		

¹Modified Hawaiian scale: Grade (G) 1 = Resistant (R) Reaction (Rn) 2-4 = Tolerant (T); 5 = Intermediate (I) and 6-9 = Susceptible (S).

²Modified Florida scale: Grade (G) 0-4 Resistant (R) Reaction (Rn) 5 = Intermediate (I) and 6-9 = Susceptible (S).

³Standard check.

⁴Rust susceptible check.

⁵Smut susceptible check.

decline in sucrose content in susceptible varieties. However, the smut affected stalks become non millable cane because of corkiness, and are dwarfed with little or no juice content (2).

Sugarcane hybrids PR 67-1355 and PR 81-1004 had intermediate levels of resistance to rust (table 4). However, PR 67-1355 is susceptible to rust in the early stages of growth but becomes much more resistant thereafter. This mature-plant resistance phenomenon has been observed for Puerto Rico (6, 11) and Florida (4). The rust-susceptible check PR 67-3129 has remained susceptible throughout the cycle crops and still remained heavily infected at harvest. This finding indicates that there was uniformity of dispersal of inoculum over the area, but the intensity of rust infection was variable.

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