

# Performance of Ten Grain Sorghum Lines from the Conversion Program<sup>1</sup>

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## ABSTRACT

Ten grain sorghum lines (*Sorghum bicolor* (L.) Moench) selected from the Conversion Program were evaluated at the Mayagüez Institute of Tropical Agriculture (MITA), Mayagüez, Puerto Rico. Grain yield among the 10 lines ranged from 910 to 4,153 kg/ha. Line 9, brown-seeded, was the highest producer. Days to mid-flower among the 10 lines ranged from 71.2 to 76.2. The high-yielding lines were late flowering. Height ranged from 83.5 to 117 cm. Weight of 10 seeds ranged from 1.63 to 2.81 g. Line 4, the lowest grain producer, had the heaviest seeds. Seed volume ranged from 1.21 to 2.20 cm<sup>3</sup>/100 seed. Line 4 had the highest volume. Density among the 10 lines ranged from 1.17 to 1.36 g/cm<sup>3</sup>. Lines 2 and 10 had the highest density. Insect damage caused by armyworms ranged from 3.3 to 4.9 (on a scale of 1 lowest to 9 highest) but no statistical differences were observed among them. Rust, the most prevalent disease observed, ranged from 0.8 to 3.8 on a scale of 1 lowest to 5 highest. The incidence of anthracnose was relatively low, ranging from 0.0 to 2.8. Zonate leaf spot ratings ranged from 0.4 to 3.1. The mean incidence of leaf blight was relatively low, ranging from 0.1 to 1.5. A multiple correlation analysis showed no significant correlation among insect and disease attacks and total grain yield. It was shown that useful sorghum material, with variations in height and maturity, and with good yield potential and resistance to pests is available in the Conversion Program for direct utilization in the tropics.

## INTRODUCTION

The Sorghum Conversion Program was first described by Stephens et al. (3) and evaluated by Eberhart (1). This program, a joint endeavor of the Texas Agricultural Experiment Station and the Mayagüez Institute of Tropical Agriculture, USDA, has resulted in the release of 183 sorghum lines which have been distributed to commercial companies, sorghum breeders, and research institutions in the U.S. and various parts of the world.

The objective of the Conversion Program is to make possible the utilization of alien sorghums under long and short days in the tropics, as well as in temperate areas. The possible utilization of the converted sorghums to broaden the gene pool and to bring in new sources of resistance to insect and disease attacks will undoubtedly facilitate the improvement of this crop.

Sorghum developed in the Conversion Program or from the program must be thoroughly evaluated as to its potential as lines per se or in hybrid combinations to provide information of value to breeders, espe-

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TABLE 1.—Description of 10 lines selected from the Sorghum Conversion Program evaluated at Isabela, Puerto Rico

Entry Number	Description	Origin	Seed color	Undercoat	Mesocarp	Midrib Dry-juicy	Plant color
1	IS 12610 (SC0110-9) × 2816 (SC0120-6)	SC0110-Ethiopia SC0120-S. Rhodesia	White	No	No	Juicy	Red
2	IS 12661 (BT×406 × PI276837) (SC0170)	Ethiopia	White	No	Yes	Juicy	Red
3	IS 1335C (BT×406 × IS1335) (SC0418)	Tanganyika	White	No	Yes	Dry	Purple
4	IS 12526C (BT×406 × PI147837) (SC0006)	Ethiopia	White	Yes	Yes	Dry	Red
5	IS 12666, TAM 2566 (SC0175-9) (BT×3105 × 276842)	Ethiopia	Brown	Yes	No	Juicy	Purple
6	IS 12666 (BT×3105 × IS 12666) (SC0175-14E)	Ethiopia	Brown	Yes	No	Juicy	Purple
7	(IS 2930 × IS 3922), sel. 74CS	Texas	Yellow	No	No	Juicy	Tan
8	(SC0599-9-3) (BT×406 × Rio)	Mississippi	Red	No	Yes	Juicy	Purple
9	IS 12666 sel. (BT×3105 × PI276842)	Ethiopia	Brown	Yes	No	Juicy	Purple
10	IS 12612C (BT×3121 × PI257603)	Ethiopia	Brown	Yes	No	Juicy	Red

cially in the tropics. The purpose of this study was to evaluate the potential usefulness of 10 lines from the Conversion Program, selected on the basis of their apparent abilities to produce superior yield and desirable morphological characters when grown under long days in Puerto Rico.

#### MATERIALS AND METHODS.

In 1975, 435 grain sorghum lines supplied by the Texas Agricultural Experiment Station were established at the Isabela Experiment Farm of the Mayagüez Institute of Tropical Agriculture (MITA) of the ARS-USDA. From these, 10 sorghum lines were selected on the basis of resistance to foliar diseases, insect attacks, weathering, and general agronomic traits.

TABLE 2.—Mean performance of 10 selected lines from the Sorghum Conversion Program evaluated at Isabela, Puerto Rico<sup>1</sup>

Line number <sup>2</sup>	Days to mid-flower	Threshing	Height	100 seed weight	Volume 100 seed	Density	Weight to 25 heads	Yield
		%	Cm	G	Cm <sup>3</sup>	G/cm <sup>3</sup>	G	Kg/ha
9	75.9 a	70.9 a	114.9 b	2.28 bcd	1.83 bcd	1.21 cd	1,455 a	4,153 a
10	75.5 a	63.2 ab	117.1 ab	2.17 ed	1.66 d	1.30 ab	1,233 ab	3,027 b
6	76.2 a	60.5 ab	108.6 ab	2.49 abc	1.96 ab	1.26 bc	1,248 a	2,881 bc
1	71.9 bc	62.1 ab	115.0 b	2.59 ab	2.02 ab	1.27 bc	1,440 a	2,303 cd
7	71.2 c	55.5 bc	128.1 a	2.43 bc	1.95 abc	1.24 bcd	1,185 ab	2,167 d
3	71.9 bc	46.7 cd	98.1 c	1.63 e	1.38 e	1.17 d	973 bc	2,032 de
5	75.6 a	52.5 bc	83.5 d	2.03 d	1.69 cd	1.20 cd	968 bc	1,829 de
2	74.9 a	51.4 bcd	114.1 b	1.66 e	1.21 e	1.36 a	958 bcd	1,659 def
8	74.5 ab	46.3 cd	96.8 c	2.22 cd	1.76 bcd	1.26 bc	700 cd	1,161 ef
4	74.6 ab	39.3 d	104.9 bc	2.81 a	2.20 a	1.27 bc	678 d	910 f

<sup>1</sup> Means with a column followed by one or more letters in common do not differ significantly at  $P < .05$  by Duncan's multiple range test.

<sup>2</sup> See table 1 for each line description.

In April 1975, the 10 sorghum selections (table 1) were shown at the rate of approximately 5 g/6.1 m row at the Isabela Experiment Farm on a Coto clay (Oxisol) with a pH ranging from 5.7 to 5.9. After emergence, the material was thinned to about 13 cm between plants. The design was balanced incomplete blocks with six replications. Each plot was 4.06 × 6.10 m with 4 rows spaced 1.02 m apart.

A complete fertilizer (15-5-10) at a rate of approximately 448 kg/ha was applied to all plots one day before planting. A similar amount of fertilizer was applied to all plots 30 days after planting. Irrigation was applied whenever necessary to maintain good growth.

Data were collected on grain yield (grain weight at 14% moisture), weight per 25 heads, plant height (average height from the ground to

the tip of the head for 4 plants/plot), days to mid-flower (number of days from planting to 50% flowering), threshing percentage, seed volume (determined by the displacement of 100 seeds in 95% alcohol), and density (the weight of 100 seeds divided by their volume and reported in g/cm<sup>3</sup>).

A rating of 1 to 9 was given to all plants on July 1, 1975 in terms of insect damage, especially armyworms, *Spodoptera frugiperda* J. E. Smith (1 = no damage to 9 = more than 75% of leaves affected). Ratings on foliar diseases were made on July 3, 1975 (1 = trace, 2 = 10%, 3 = 25%, 4 = 50%, 5 = 100% leaf blade infection).<sup>3</sup> The following diseases were studied: rust (*Puccinia purpurea* CKe); anthracnose (*Colletotrichum graminicolum* (Ces) C. W. Wils.); zonate leaf spot (*Gloeocercospora sorghi* Ell. & Ev.); and leaf blight (*Helminthosporium turcicum* Pass.).

## RESULTS AND DISCUSSION

### YIELD PERFORMANCE

The performance of the 10 lines is summarized in table 2. Days to mid-flower ranged from 71.2 to 76.2. The best grain-yielding lines, 6, 9, and 10 were also among the latest in flowering.

Threshing percentages ranged from 39.3 to 70.9%. Line 9 had the highest threshing percentage, although no significant differences<sup>4</sup> existed between this selection and lines 10, 1, and 6. Lines 2, 3, 8, and 4 exhibited the lowest threshing percentage (39.3 to 51.4); no significant differences were observed among them.

Height ranged from 83.5 to 128.1 cm. Lines 10, 1, 9, 2, 6, and 4 had heights ranging from 117 to 105 cm; no significant differences were observed among them. Line 7 was tallest; line 5 was significantly shorter than the remaining lines.

The components of grain yield studied were seed weight, seed volume, and density (table 2). The weight of 100 seeds ranged from 1.63 to 2.81 g. Line 4, the lowest grain producer, had the highest seed weight. Seed weight of lines 4, 1, and 6 were not significantly different but they were superior to most of the remaining selections. Line 9, the best grain producer, was outweighed by line 4. The lowest seed weights were observed among lines 2 and 3.

Seed volume ranged from 1.21 to 2.20 cm<sup>3</sup>/100. Line 4 had the highest volume. Lines 2 and 3 had the lowest value and had significantly lower volume than the remaining selections.

The highest densities were observed in lines 2 and 10 with 1.36 and

<sup>3</sup> Appreciation is expressed to Dr. R. Rodrigo Alconero for his help in the disease evaluation of the 10 lines.

<sup>4</sup> Here, as elsewhere, significant difference means differences at the 5% level.

1.30 g/cm<sup>3</sup>, respectively; these values were significantly higher than those of the remaining lines. The lowest density values were observed in lines 7, 9, 5, and 3.

The weight of 25 heads ranged from 678 to 1,455 g for the 10 lines. Line 9 had the highest weight. Lines 2, 8, and 4 had the lowest weight; no significant differences were observed among them.

Grain yield among the 10 lines ranged from 910 to 4,153 kg/ha. Line 9, a brown-seeded sorghum, was the highest producer. The second best yielders were lines 10 and 6 with 3,027 and 2,881 kg/ha, respectively. Line 7, a yellow endosperm selection, produced 2,167 kg/ha.

Few reports are available concerning the evaluation of grain sorghums in Puerto Rico. Wahab et al. (4) measured grain yields of slightly over 2,600 kg/ha for RS671, a well adapted sorghum for the tropics, at

TABLE 3. — Mean insect and disease ratings of 10 selected sorghum lines from the Conversion Program evaluated at Isabela, Puerto Rico<sup>1</sup>

Line number <sup>2</sup>	Insect rating	Disease ratings			
		Rust	Anthraco-nose	Zonate leaf spot	Leaf blight
6	4.9 <sup>3</sup>	0.8 c	0.0 c	0.4 b	0.2 b
4	4.9	1.2 c	.1 c	.7 b	.1 b
5	4.8	1.2 c	2.3 a	.8 b	.3 b
8	4.3	1.2 c	1.9 b	1.0 b	1.5 a
3	4.1	2.4 b	.0 c	1.6 b	.9 ab
1	4.1	3.5 a	.2 c	.7 b	.1 b
10	3.9	3.5 a	.3 c	1.6 b	.2 b
2	3.7	3.8 a	.5 c	3.1 a	.9 ab
9	3.7	1.2 c	.8 c	.4 b	.5 b
7	3.3	2.3 b	.2 c	.9 b	.1 b

<sup>1</sup> Means within a column followed by one or more letters in common do not differ significantly at  $P < .05$  by Duncan's multiple range test.

<sup>2</sup> See table 1 for each line description.

<sup>3</sup> Nonsignificant.

Barranquitas and Corozal, Puerto Rico, in an Oxisol and Ultisol, respectively. The maximum grain sorghum yields reported by Fox et al. (2) on soil series of the orders Ultisol and Oxisol, utilizing RS671 in Puerto Rico was 4.3 metric tons/ha.

In this study, line 10 produced grain sorghum yields of 4,153 kg/ha (table 1). It appears that under intensive management and with proper fertilizer applications, grain sorghum yields of over 4,000 kg/ha can be obtained with nonhybrid material.

#### RESISTANCE TO INSECTS AND DISEASES

No report is available in Puerto Rico concerning the evaluation of grain sorghums in terms of their reactions to insects and diseases. This

information is necessary for the final selection of desired genotypes and its relationship to total yield.

The mean ratings on insect and disease attacks on the 10 lines are shown in table 3. The ratings on insect damage, mostly armyworms, ranged from 3.3 to 4.9, but no significant differences were observed among the 10 lines. The most affected line was 6, while line 7 was the most resistant to the armyworm's attack (table 3).

Rust was observed on the 10 lines, ranging from 0.8 to 3.8. The most susceptible lines were 1, 2, and 10; their means were significantly different from the remaining selections. A third group of lines, 6, 5, 4, 8, and 9 exhibited significantly lower infection values than the remaining 5 selections.

Anthracnose readings among the 10 lines were relatively low, with lines 5 and 8 having the highest values. In this experiment, anthracnose was not observed in lines 6 and 3.

Zonate leaf spot mean values ranged from 0.4 to 3.1. Line 2 exhibited the highest zonate leaf spot incidence, being significantly different from the remaining 9 lines.

The incidence of leaf blight disease was low. Its mean values ranged from 0.1 to 1.5. Line 8 had the highest value, 1.5, being significantly different from all lines except 2 and 3.

Of the diseases studied, rust was the most prevalent among the 10 lines. A mean rating of 2.2 was obtained versus 0.6, 1.1, and 0.4 for anthracnose, zonate leaf spot, and leaf-blight, respectively. No significant correlations were observed among insect and disease ratings and total yield.

The results obtained herein provide the first information concerning the evaluation in Puerto Rico of lines resulting from the Conversion Program. It was shown that yields of over 4,000 kg/ha can be obtained with brown-seeded lines. Yields of over 2,000 kg/ha were obtained on white-seeded lines that could be utilized directly for human consumption in the tropics.

#### RESUMEN

Diez líneas de sorgo de grano (*Sorghum bicolor* (L.) Moench) seleccionadas del Programa de Conversión se evaluaron en la finca experimental de Isabela del Instituto Mayagüezano de Agricultura Tropical.

La producción de grano fluctuó en las 10 líneas entre 910 y 4,153 kg/ha. La línea 9, de semilla marrón, produjo más. Los días transcurridos entre la siembra y la mitad de la floración fluctuaron en las 10 líneas de 71.2 a 76.2. Las líneas más tardías produjeron más. El peso de 100 semillas en las 10 líneas fluctuó entre 1.63 y 2.18 g. La línea 4, la peor productora, tuvo el peso de semilla más alto. El volumen de semilla en las 10 líneas fluctuó entre 1.21 y 2.20 cc/100 semillas; la densidad fluctuó entre 1.17 y 1.36 g/cc. El daño causado por el ataque del gusano (armyworm) *Spodoptera frugiperda* fue similar y fluctuó en las 10 líneas entre 3.3 y 4.9 (en una escala de 1—más bajo, al 9—más alto). La roya de la hoja fue la enfermedad de mayor importancia y fluctuó entre 0.8 y 3.8. La incidencia de antracnosis fue relativamente baja y fluctuó entre 0.00 y 2.80. La mancha circular de la hoja (zonate leaf spot) fluctuó entre 0.4 y 3.1. La incidencia media de la

mancha de la hoja causada por *Helminthosporium turcicum* fue también relativamente baja y en las 10 líneas fluctuó entre 0.1 y 1.5. Según un análisis de correlación múltiple no existe correlación significativa entre los ataques de insectos, enfermedades y producción total de grano.

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