

Performance of F₁ Hybrids from Crosses of Three Sudangrasses and Six Forage Sorghums with A Rhodesian Sudangrass¹

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ABSTRACT

A cytoplasmic male-sterile sudangrass (A Rhodesian) was crossed with three other sudangrasses (Common, Greenleaf, and Piper) and six forage sorghums (Sart, Millo Blanco, Bloomless, Forage Sorgo × Sugar Drip, Collier, and Brawley). The nine F₁ hybrids were compared for yield of green forage (GF), yield of dry forage (DF), crude protein (CP) content, CP yield, and height at Isabela, Puerto Rico. Four cuttings were made. The first was 45 days after planting and the remaining three were at about 30-day intervals thereafter. The second harvest had the highest DF yield but the lowest CP content. The CP content was 15.7, 12.2, 14.6, and 15.6% for harvests 1, 2, 3, and 4, respectively. When data for all four harvests were combined, the F₁ hybrid of A Rhodesian sudangrass × Common produced the highest GF and DF yields, 143 kg·ha⁻¹·day⁻¹ of the latter which was 30% and 29% more than the 2nd- and 3rd- highest DF producing hybrids. Differences in CP content among the nine F₁ hybrids were not significant, but A Rhodesian sudangrass × Common produced the highest CP yields. The tallest F₁ hybrids were A Rhodesian × Common and A Rhodesian × Greenleaf. The GF and DF yields of A Rhodesian × Common were excellent. The results indicated that A Rhodesian sudangrass is a male-sterile line with potential for use in the development of superior F₁ forage-sorghum hybrids in Puerto Rico.

INTRODUCTION

In the United States, forage sorghums (*Sorghum bicolor* (L.) Moench) are grown as "summer annual crops." About 25% of the total sorghum hectareage grown in the United States is forage sorghum; the other 75% is grown for grain or seed (2).

In Puerto Rico, forage sorghums have a great potential for production throughout the year, but few reports are available concerning the use of this crop, which at present is limited mainly to some plantings in the northern and southwestern parts of the island. The literature on such use is not extensive. Vázquez et al. (7) reported DF yields of over 35 tons per hectare with Millo Blanco, a local forage-sorghum variety. Sotomayor-Rios and Telek (6) obtained DF yields of about 17 tons with hybrid CK-60 × Millo Blanco, with an average crude protein content of 17.6%, during a 211-day period at Isabela. Morales (3), evaluating a series of forage-sorghum hybrids and sorgo-sudan hybrids at Isabela, reported yields of over 40 tons of DF/ha yearly when the forage was harvested at 45 days.

In Hawaii, Plucknett et al. (4) reported that yields from forage sor-

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ghums were excellent in lowland and coastal areas, but fair to poor in higher, cooler areas.

This study was conducted in order to evaluate the performance in northwestern Puerto Rico of nine F_1 hybrids for which line A Rhodesian sudangrass, a cytoplasmic male-sterile line, was the female parent. Line A Rhodesian was developed from Rhodesian sudangrass (P.I. 156549) and Combine Kafir-60 (CK-60) by Craigmiles in Georgia (1). It was developed by a series of backcrosses in which CK-60 cytoplasmic male-sterile factors were transferred to Rhodesian sudangrass.

MATERIALS AND METHODS

In 1976, hand crosses were made between A Rhodesian sudangrass and three other sudangrasses (Piper, Common, Greenleaf) and between A Rhodesian sudangrass \times six forage sorghums (Sart, Millo Blanco, Bloomless, Collier, Brawley, and Forage Sorgo \times Sugar Drip). Bloomless forage-sorghum seed was supplied by Dr. Dale Weibel of Oklahoma State University; the remaining sudangrasses and forage sorghums are well-known varieties for which seed is readily available.

The experiment was conducted at the Isabela experiment farm of MITA, AR-SEA-USDA, in northwestern Puerto Rico. The farm is 128 m above sea level, and temperatures range from 18° to 31° C. The soil is a Coto clay (Oxisol) with pH ranging 5.0 to 5.5. The nine F_1 hybrids were planted (with the aid of a small tractor) April 4, 1977. The seeding rate was about 12 kg/ha. Immediately after planting, propazine³ [2-chloro-4,6-bis(isopropylamino)-s-triazine] was applied for weed control to all plots at 2 to 3 kg of active ingredient/ha. Two weeks after planting, a complete fertilizer (15-5-10) was applied to all plots at about 560 kg/ha.

A complete block design with four replications was used. Plots consisted of two rows spaced 101 cm apart and 5 m long. Sampling area was 4 m². The first cutting was made 45 days after planting and subsequent harvests were made about every 30 days thereafter. After each of the four cuttings and throughout the duration of the experiment, N at the rate of about 83 kg/ha in a 15-5-10 fertilizer was applied to all plots. Overhead irrigation was applied whenever necessary.

Before each cutting, plant height from the ground to the midpoint of the last leaf was measured for two plants per plot, chosen at random, in all treatments. Yield of green forage (GF) per plot was calculated for each harvest. Samples were analyzed for DF and CP content at MITA labo-

³ Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

ratories. Data were subjected to analysis of variance, and significant differences were identified with Duncan's multiple range test.

RESULTS AND DISCUSSION

Table 1 shows the mean GF yield, DF yield, CP yield, CP content, and height across the nine F_1 hybrids at each harvest. The forage yields were usually highest at harvest 2, but the CP content was the lowest at this stage. The wide range in production at each harvest was due to the great variability among F_1 hybrids. Yields of GF and DF in harvests 3 and 4 were very similar. In general, the plants were tallest at harvest 2; thus the greatest height coincided with the highest GF and DF yields.

Table 2 shows the mean yields, CP content, and height for each of the

TABLE 1.—Mean and range in yields of green forage, dry forage, and crude protein; crude protein content, and height across nine F_1 forage-sorghum hybrids at four harvests

Characteristic	Mean and range at each harvest			
	(1) 5/18/77	(2) 6/23/77	(3) 7/21/77	(4) 8/22/77
Green forage yield (kg/ha)	16,614 (19,766-8,716)	27,541 (43,063-21,625)	21,500 (31,256-11,160)	22,819 (34,688-14,813)
Dry forage yield (kg/ha)	2,598 (3,005-1,358)	4,294 (5,745-3,351)	3,848 (5,871-2,238)	3,725 (5,602-2,636)
Crude protein (%)	15.7 (18.5-14.4)	12.2 (13.4-11.5)	14.6 (16.5-13.1)	15.6 (18.9-14.1)
Crude protein yield (kg/ha)	394 (508-222)	520 (661-414)	557 (764-354)	572 (789-403)
Height (cm)	118 (131-94)	157 (176-131)	122 (150-107)	123 (146-102)

nine F_1 hybrids across the four harvests. The GF yields ranged from 126,375 to 51,125 kg/ha. The F_1 hybrid of A Rhodesian \times Common sudangrass produced the highest GF yield, although this was not significantly different from that of A Rhodesian \times Sart. The F_1 hybrid of A Rhodesian \times Piper sudangrass produced the lowest GF yield.

The F_1 hybrid of A Rhodesian \times Common sudangrass produced the highest DF yields, significantly higher than those of the remaining eight F_1 hybrids. This hybrid produced 29% and 30% more than A Rhodesian \times Sart and A Rhodesian \times Greenleaf the 2nd and 3rd highest DF producers, respectively. The DF yields of A Rhodesian \times Common are excellent compared with those of perennial tropical grasses. At Isabela, Sotomayor-Ríos et al. (5) studied the effect of harvest intervals on 10 forage grasses. At the 30-day interval, the best yielder, Transvala digitgrass (*Digitaria decumbens* Stent), produced about 29,000 kg/ha in 1 year, whereas A Rhodesian \times Common sudangrass produced almost 69%

of that yield in only 140 days. In Hawaii the DF yield of Haygrazer, a high-yielding forage sorghum, was reported to be $134 \text{ kg} \cdot \text{ha}^{-1} \cdot \text{day}^{-1}$ (4), whereas the yield of A Rhodesian \times Common sudangrass in this study was $143 \text{ kg} \cdot \text{ha}^{-1} \cdot \text{day}^{-1}$.

No significant differences in CP content were observed among the nine F_1 hybrids. The average was 14.5%. This value is lower than that reported by Sotomayor-Ríos and Telek (6) for Redlan \times Millo Blanco when this F_1 hybrid was evaluated at Isabela during a 211-day period.

The CP yields of the nine F_1 hybrids ranged from 2,712 to 1,391 kg/ha. The F_1 hybrid of A Rhodesian \times Common produced the highest CP yield,

TABLE 2.—Mean yields of green forage, dry forage, and crude protein; crude protein content; and height in nine F_1 forage-sorghum hybrids of A Rhodesian (female parent) across four harvests at Isabela, P. R.¹

Male parent of hybrid	Green forage yield	Dry forage yield	Crude protein ²	Crude protein yield	Height
	<i>Kg/ha</i>	<i>Kg/ha</i>	%	<i>Kg/ha</i>	<i>Cm</i>
Common sudangrass	126,375 a	20,039 a	14.3	2,712 a	148 a
Sart sorghum	101,687 ab	15,362 b	14.2	2,124 ab	137 bc
Greenleaf sudangrass	90,563 bc	15,591 b	14.4	2,199 ab	141 ab
Brawley sorghum	88,813 bc	14,679 b	14.7	2,120 ab	119 e
Millo Blanco sorghum	86,500 bc	13,723 b	14.4	1,948 b	126 de
Bloomless sorghum	82,750 bc	13,578 b	14.8	1,988 b	127 de
Forage Sorgo \times Sugar Drip	81,938 bc	13,631 b	13.8	1,830 b	134 bcd
Collier sorghum	71,625 c	11,543 bc	15.0	1,705 b	129 cde
Piper sudangrass	51,125 d	9,464 c	15.2	1,391 c	110 f
\bar{X}	86,820	14,179	14.5	2,002	130
C.V.	19.5%	18.7%	7.4%	20.2%	5.1%

¹ Data are means across four replicate plots and four harvests. In each column, means followed by one or more letters in common do not differ significantly ($P = .05$), according to Duncan's multiple range test.

² Differences were nonsignificant.

but this was not significantly different from those of A Rhodesian \times Sart, A Rhodesian \times Greenleaf, and A Rhodesian \times Brawley. A Rhodesian \times Piper had the lowest CP yield.

The F_1 hybrids of A Rhodesian \times Common sudangrass and A Rhodesian \times Greenleaf were, on the average, the tallest of all hybrids at 148 and 141 cm, respectively. These were significantly taller than the other hybrids.

It can be concluded that A Rhodesian sudangrass is a male-sterile line with potential for use in the development of forage hybrids. When this line was crossed with Common sudangrass, the F_1 hybrid gave the outstanding yield of more than 20,000 kg/ha of DF in 140 days or $143 \text{ kg} \cdot \text{ha}^{-1} \cdot \text{day}^{-1}$, with an average CP content of about 14.3, based on cutting at 30-day intervals.

RESUMEN

En la finca experimental MITA de Isabel, Puerto Rico, el pasto sudán androestéril, A Rhodesian, se cruzó con tres pastos sudán (Common, Greenleaf y Piper) y con seis sorgos forrajeros (Sart, Millo Blanco, Bloomless, Forage sorgo × Sugar Drip, Collier y Brawley). Los nueve híbridos F_1 se evaluaron en términos de forraje verde (GF), materia seca (DM), y proteína bruta (CP), y altura durante 140 días. El estudio se llevó a cabo en un Oxisol en la zona noroeste de Puerto Rico. Se llevaron a cabo cuatro cortes; el primero a los 45 días después de la siembra y subsiguientemente cada 30 días, aproximadamente.

Al combinar los cuatro cortes, la producción de GF y DF del híbrido A Rhodesian sudan × Common, fue 30% y 29% mejor que los de A Rhodesian × Sart y A Rhodesian × Greenleaf. No se observaron diferencias significativas entre los nueve híbridos en términos de CP, pero la producción de CP fue significativamente más alta en el híbrido A Rhodesian × Common, con 2712 kg/ha.

Los híbridos A Rhodesian × Common y A Rhodesian × Greenleaf fueron en promedio los más altos. Se concluye que el pasto sudán androestéril A Rhodesian, es una línea prometedora con magníficas potencialidades para ser utilizada en el desarrollo de híbridos forrajeros. La producción de DF del híbrido F_1 A Rhodesian × Common de sobre 20,000 kg/ha en un período de 140 días o de $143 \text{ kg} \cdot \text{ha}^{-1} \cdot \text{día}^{-1}$ con una CP de 14.3% es excelente, especialmente cuando el pasto puede ser cosechado en los trópicos cada 30 días.

LITERATURE CITED

1. Craigmiles, J. P., 1961. The development, maintenance, and utilization of cytoplasmic male sterility for hybrid sudangrass seed production, *Crop Sci.* 1:150-2.
2. Fribourg, H. A., 1973. Summer annual grasses and cereals for forage, p. 344-57. In *Forages*, Iowa State Coll. Press, Ames.
3. Morales, A., 1976. Annual report on development of improved high yielding sorghum cultivars. Contract No. AID/ta-C1087, June 1, 1975-May 31, 1976, *Agri. Exp. Stn., Univ. P. R., Mayagüez, P. R.*
4. Plucknett, D. L., Younge, O. R., Izuno, T., Tarini, Y. U., and Ishizaki, S. M., 1971. Sorghum production in Hawaii *Agri. Exp. Stn. Bull.* 143.
5. Sotomayor-Ríos, A., Juliá, F., and Arroyo-Aguilú, J. A., 1974. Effects of harvest intervals on the yield and composition of 10 forage grasses, *J. Agri. Univ. P. R.* 58 (4):448-55.
6. —and Telek, L., 1977. Forage yield and protein content of Millo Blanco (*Sorghum bicolor*) and two F_1 hybrids, *J. Agri. Univ. P. R.* 61 (3):300-4.
7. Vázquez, R., Eschenwald-Hess, A., and Martínez-Luciano, M. J., 1966. Response of native white sorghum to irrigation under different nitrogen-fertility levels and seeding rates in Lajas Valley, P. R., *J. Agri. Univ. P. R.* 50 (2):73-112.