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Comparison of F₁'s and Inbreds as Female Parents for Sorghum-Sudangrass Seed Production¹

H. J. Gorz, J. J. Toy, F. A. Haskins, and W. M. Ross²

ABSTRACT

Two field studies involving different groups of germplasm were conducted to compare sorghum-sudangrass, *Sorghum bicolor* (L.) Moench × *S. sudanense* (Piper) Stapf, hybrid seed production of male-sterile F₁'s with their component A-lines. The F₁'s yielded 45 and 82% more grain than their A-line counterparts in Study 1 and 2, respectively, with the increase attributable to more seeds per panicle and a greater threshing percentage. Mean values of nine traits measured on nine groups of eight F₁'s in Study 1 and seven groups of six F₁'s in Study 2 were compared with their respective A-lines. All groups of F₁'s significantly outyielded their A-line counterparts in both studies except for A-line N35 in Study 1. Phenotypic correlations of yield and seeds per panicle were high in both A-lines and F₁'s in both studies, as were the correlations of yield and threshing percentage except for the F₁'s in Study 1. Application of these findings should facilitate the production of higher yields of sorghum-sudangrass hybrid seed at reduced cost per unit of seed. The best F₁'s to use and the magnitude of their superiority over A-lines will be influenced by the location in which seed is produced.

Additional index words: *Sorghum bicolor* (L.) Moench, *Sorghum sudanense* (Piper) Stapf, Single-cross hybrids, Three-way hybrids.

SORGHUM-SUDANGRASS, *Sorghum bicolor* (L.) Moench × *S. sudanense* (Piper) Stapf, hybrids are grown extensively to provide supplementary forage for animals as pasture, silage, or greenchop. These hybrids play an important role in the management plans of many livestock producers, particularly in drouth-prone regions such as the Great Plains.

In a 1977 survey by Harvey (1), 81.5% of the commercially produced sorghum-sudangrass hybrids in the United States were F₁'s, with 'Redlan' grain sorghum being the preferred male-sterile and 'Greenleaf' sudangrass the most often used pollinator. Also, three-way cross hybrids made up 11% of the total seed production of sorghums and sudangrasses used for forage compared with less than 2% in grain sorghum (1). Despite this rather extensive use of three-way crosses in forage and sudangrass hybrids, only two preliminary reports were found in which the seed production of three-way and single cross hybrids was compared. In a 1-year study of seed production of sorghum-sudangrass hybrids in Hungary (3), seed yields of F₁ male steriles were greater and production was more dependable than for A-lines because the F₁'s matured earlier, but comparative seed yields of three-way and single cross hybrids were not presented. In Japan (6), four grain sorghum A-lines, six grain-sorghum male-sterile F₁'s and six sorgho male-sterile F₁'s were used in a comparative

study of seed production of forage sorghum hybrids. Seed weight per head on the grain-sorghum male-sterile F₁'s was slightly lower than for the A-lines, while seed weight per head on the sorgho male-sterile F₁'s was substantially greater than on either of the other two female types. Seed yield per land area was not given. The A-lines used differed in each of the three groups of material, and seed weights of F₁'s could not be compared with those of their component A-lines.

Although published information on comparisons of three-way with single cross forage-type hybrids is limited, more extensive literature is available for grain sorghums as indicated in a recent report (2).

The objectives of this study were to 1) compare seed yield and other agronomic traits between male-sterile F₁ seed parents and their component A-line seed parents in the production of sorghum-sudangrass hybrids in two different groups of germplasm, 2) determine phenotypic correlations among traits within parental groups, and 3) relate the findings to hybrid seed production. Evaluation of the hybrid seed produced in terms of forage production will be reported in a subsequent paper.

MATERIALS AND METHODS

The seed parents used in Study 1 were nine combine-height cytoplasmic male-sterile A-lines and their 36 male-sterile A × B-line crosses (F₁'s) that were identical to those used in a similar study with grain sorghum hybrids (2). The A-lines included KS4, KS23, 'Martin', N30, N35, N36, N38, WD4, and 'Wheatland'. In Study 2, the seed parents were seven A-lines and their 21 male-sterile F₁'s. The A-lines were KS5 and KS9, described by Ross et al. (4); N38 and N48, described by Ross et al. (5); N4692, described by Webster et al. (7); N5013, an experimental line; and the cultivar Redlan.

The pollen source was produced from a composite of equal seed weights of the sudangrass cultivars Greenleaf and 'Piper', Nebraska 7035, and experimental low-dhurrin strains of Greenleaf and Piper. This heterogeneous pollen source assured continuous and adequate pollen dispersal to the female parents over the range of their stigma receptivity. The sudangrass composite was seeded in double rows, with six rows of male-sterile sorghums being grouped between each pair of sudangrass rows. The outside rows of each group of six male-steriles were seeded to cytoplasmic male-sterile 'Combine Kafir-60', which served as unharvested border rows to minimize any effect of the taller sudangrass rows on the four randomly assigned male-sterile lines and F₁ hybrids that were harvested in each group.

The experiments were planted 29 May 1979 and 27 May 1980 at the University of Nebraska Field Laboratory, Mead, in a medium textured Sharpsburg silty clay loam soil (fine, montmorillonitic, mesic Typic Argiudoll) to which 112 kg ha⁻¹ of N had been applied. Four replications of single-row plots 7.6 m long and 0.76 m apart in a randomized complete block design were used each year. All plots were overseeded and thinned to 15 cm between plants, giving a plant population of about 87 000 plants ha⁻¹. The exper-

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Table 1. Means and coefficients of variation (C.V.) for nine traits of A- × B-line F₁'s and A-lines used as female parents in the production of sorghum-sudangrass hybrids in two studies at Mead, Nebr., 1979-1980.

Trait	Study 1†				Study 2†			
	Parental group		F ₁ 's vs. A-lines	CV	Parental group		F ₁ 's vs. A-lines	CV
	F ₁ 's	A-lines			F ₁ 's	A-lines		
				%				%
Flowering, days‡	58**	60**	**	2.4	62**	64**	**	2.2
Height, cm	105**	97**	**	3.6	128**	111**	**	4.6
Yield, kg ha ⁻¹	5609**	3872**	**	13.4	5784**	3171**	**	16.6
100-seed weight, g	2.43**	2.59**	**	4.6	2.20**	2.16**	NS§	3.6
Panicles per plant, no.	1.88**	1.88**	NS	14.2	1.90**	1.99**	NS	18.2
Seeds per head, no.	1958**	1325**	**	12.7	2104**	1200**	**	12.0
Threshing, %	81 NS	77**	**	7.3	81**	73**	**	6.4
Germination (10 & 25°C), %¶	92*	87**	**	4.4	94**	88 NS	**	3.6
Germination (25°C), %	93**	89**	**	4.2	94*	89*	**	3.2

*,** Significant at the 0.05 and 0.01 probability levels, respectively, for entries within F₁'s and within A-lines, and for F₁'s vs. A-lines.

† A-lines included in Study 1 were KS4, KS23, Martin, N30, N35, N36, N38, WD4, and Wheatland; those in Study 2 were KS5, KS9, N38, N48, N4692, N5013, and Redlan.

‡ Days from planting until most plants had 50% of the panicle in anthesis.

§ NS is nonsignificant.

¶ One week at 10°C followed by 1 week at 25°C.

imental unit consisted of a 4.4-m row segment with a good stand of plants.

Data were collected on nine traits. Analyses of variance were based on standard procedures where entries were partitioned into F₁'s, A-lines, and F₁'s vs. A-lines. The F₁'s were further broken down into sets having a common A-line and were tested against their common A-line by a single degree of freedom comparison. Phenotypic correlations were determined among agronomic traits within the two groups of seed parents in each study.

RESULTS AND DISCUSSION

Differences were significant among A-lines and among F₁'s for all characters in both studies except threshing percentage among F₁'s in Study 1 and germination at 10 and 25°C among A-lines in Study 2 (Table 1). Differences between A-lines and F₁'s also were significant for all traits except panicles per plant in both studies and 100-seed weight in Study 2. F₁'s, on the average, were earlier, taller, and had higher germination percentages than the lines, with the greatest difference in germination being found when seeds were germinated initially at low temperature. This advantage could be important in achieving successful stands under cool soil conditions. F₁'s also yielded 45 and 82% more grain than their A-line counterparts in Study 1 and 2, respectively. The yield increase of the F₁'s was attributable to more seeds per panicle and a greater threshing percentage. This increase was in general agreement with two recent preliminary reports of sorghum-sudangrass hybrid seed production studies (3, 6), but neither of these reports included a comparison of F₁'s with their respective A-lines. When the same male-sterile females used in Study 1 were pollinated by grain sorghums instead of sudangrasses, the F₁ hybrids outyielded the A-lines by 54%, with the F₁'s having 52% more seeds per head, 3% more heads per plant, and a 7% greater threshing percentage (2).

Mean values of the characters measured on each group of F₁'s having a common A-line were compared with their respective A-line values (Table 2). All groups of F₁'s significantly outyielded their A-line counterparts in both studies except for N35 in

Study 1. An increased number of seeds per panicle and a greater threshing percentage in the F₁'s contributed most to the yield advantage of the F₁'s. In many of the comparisons, F₁'s also were significantly taller and earlier in maturity, and had significantly higher germination percentages. Differences between F₁'s and A-lines for 100-seed weight and panicles per plant were mostly nonsignificant.

The data collected in these experiments permitted the calculation of phenotypic correlations that show the relationships among the seven traits listed in Table 3. Yield and seeds per panicle were significantly and positively correlated in F₁'s as well as A-lines in both studies, while the correlations of yield and threshing percentage also were positive and significant except in the F₁'s in Study 1. Other significant correlations in the F₁'s of Study 1 included negative associations of flowering with height, and seeds per panicle with 100-seed weight, while there were positive relationships of flowering with yield, yield with panicles per plant, and flowering with panicles per plant. Correlations of height and panicles per plant were significant and negative in both the F₁'s and A-lines in Study 1. In the F₁'s of Study 2, significant positive correlations were obtained between grain yield and height, seeds per panicle and height, and 100-seed weight and threshing percentage.

Comparison of the highest yielding F₁'s and A-lines in these experiments revealed that there was an association of yield in A-lines and the F₁'s in which they were involved in some but not all comparisons. For example, in Study 1, N38, Wheatland, and N36 were represented 13 times in the 10 highest yielding F₁'s, and were among the four highest yielding A-lines. However, KS4 was the second highest yielding A-line but was not represented at all among the 10 highest yielding F₁'s while appearing in 6 of the lowest yielding F₁'s. In Study 2, a closer relationship existed between yield in A-lines and F₁'s in which they were involved than was found in Study 1. N4692 was the highest yielding A-line and it was involved in four of the five highest yielding F₁'s. The three lowest yielding A-lines, KS9, N48, and Redlan, were represented 13 times among the 10 lowest yielding F₁'s.

Table 2. Means of nine traits in sets of A- × B-line F₁'s compared with their common A-line used as sorghum-sudangrass female parents in two studies at Mead, NE, 1979-1980.

Inbred line	Parental group	Flowering†	Height	Yield	100-seed weight	Panicles per plant	Seeds per panicle	Threshing	Germination	
									10 & 25°C‡	25°C
		days	cm	kg ha ⁻¹	g	no.		%	%	
Study 1										
KS4	F ₁	57	104	5139*	2.49	1.72	1835**	82*	92	93
	A	58	99	4233	2.62	1.82	1448	76	90	92
KS23	F ₁	57	109**	5425**	2.36	1.78	2025**	80**	91**	92**
	A	57	95	2578	2.27	1.80	1053	69	75	74
Martin	F ₁	57	107**	5378**	2.45	1.85	1838**	82	93	93
	A	56	97	3944	2.69	2.06	1223	80	92	95
N30	F ₁	59	105	5550**	2.63**	1.86	1897**	83*	93**	93
	A	60	104	3710	3.07	1.67	1105	77	87	90
N35	F ₁	59*	106*	5724	2.34	1.90	2113	80	92	93
	A	61	100	5017	2.48	1.73	2034	82	89	91
N36	F ₁	59**	109	5996**	2.25	1.99	2115**	82	92*	93
	A	64	104	3974	2.06	1.98	1567	78	87	90
N38	F ₁	60	100**	6111**	2.28	2.02	2067**	81	93	93
	A	62	83	4132	2.30	2.25	1277	78	89	92
WD4	F ₁	59**	106*	5172**	2.44	1.84*	1779**	79	93**	92**
	A	63	100	3071	2.45	1.51	1090	73	87	87
Wheatland	F ₁	59**	102**	5982**	2.65**	1.92	1956**	80	93	94*
	A	63	91	4191	3.35	2.04	1128	78	90	90
Study 2										
KS5	F ₁	59	138**	6131**	2.10**	2.04	2230**	81	94	94
	A	57	111	3465	1.80	1.98	1501	76	91	91
KS9	F ₁	63**	121**	5134**	2.12	1.70	2062**	80**	93**	94**
	A	67	103	1832	2.19	1.48	835	64	85	87
N38	F ₁	61	113**	5821**	2.16	1.95**	2051**	82	94*	94*
	A	61	79	3485	2.23	2.68	1100	77	89	90
N48	F ₁	63**	126**	5330**	2.18	2.08**	1802**	79**	93*	94*
	A	67	108	2677	2.03	2.55	937	68	88	88
N4692	F ₁	62*	136	6151**	2.15	1.87	2325**	80	94*	95**
	A	63	138	3779	2.07	1.99	1462	73	88	87
N5013	F ₁	64**	134	6026**	2.22	1.94	2155**	82	94*	95*
	A	67	133	3680	2.07	1.68	1400	78	88	91
Redlan	F ₁	61	127**	5894**	2.48*	1.71	2101**	82*	94*	95
	A	62	104	3278	2.76	1.57	1166	73	88	92

*,** Significant at the 0.05 and 0.01 probability levels, respectively. All other comparisons were nonsignificant.

† Days from planting until most plants had 50% of the panicle in anthesis.

‡ One week at 10°C followed by 1 week at 25°C.

Table 3. Phenotypic correlations among seven traits in A- × B-line F₁'s (first line) and A-lines (second line) in Study 1 (above diagonal) and Study 2 (below diagonal) of female parents used for seed production of sorghum-sudangrass hybrids at Mead, NE in 1979-1980.†

Trait	Flowering	Height	Yield	100-seed weight	Panicles per plant	Seeds per panicle	Threshing
Flowering, days		-0.48**	0.54**	-0.11	0.48**	0.26	-0.08
Height, cm	-0.19		0.22	-0.05	-0.06	0.20	0.20
	0.27		-0.17	-0.30	-0.38*	0.23	0.01
Yield, kg ha ⁻¹	-0.39	0.52*		-0.04	-0.68*	0.25	0.03
	-0.45	0.35		0.20	0.50**	0.72**	0.23
100-seed weight, g	0.13	0.03	0.13		0.33	0.77*	0.90**
	0.08	-0.30	-0.08		-0.18	-0.57**	0.06
Panicles/plant, no.	-0.31	0.26	0.28	-0.40		-0.33	0.23
	-0.15	-0.43	0.21	-0.31		0.14	-0.01
Seeds/panicle, no.	-0.27	0.49*	0.76**	-0.09	-0.12		0.37
	-0.51	0.60	0.86**	-0.34	-0.11		0.10
Threshing, %	-0.17	0.04	0.57**	0.44*	-0.02	0.37	
	-0.48	0.10	0.92**	-0.06	0.23	0.75	

*,** Significant at the 0.05 and the 0.01 probability levels, respectively.

† df = 34 for F₁'s and 7 for A-lines in Study 1; 19 for F₁'s and 5 for A-lines in Study 2.

The seed yield of F₁ male-steriles was superior to that of their A-line counterparts in both studies, and the earlier maturity of the F₁ hybrids may reduce the need for seed drying. Also, additional progress in the development and use of improved F₁ male-steriles should be possible if A- and B-line combinations are selected on the basis of their genetic combining ability. Application of these findings should facilitate the production of higher yields of sorghum-sudangrass hybrid seed at reduced cost per unit of seed. The

best F₁'s to use and the magnitude of their superiority over A-lines will be influenced by the location in which seed is produced.

REFERENCES

- Harvey, P.H. 1977. Sorghum germplasm base in the U. S. Corn and Sorghum Res. Conf., Proc. 32:186-198.
- Hookstra, G.H., and W.M. Ross. 1982. Comparison of F₁'s and inbreds as female parents for hybrid sorghum seed production. Crop Sci. 22:147-150.
- Lazanyi, J., and S. Papp. 1981. Seed production and yield of

- three-way cross hybrid sudangrass. *Sorghum Newsl.* 24:4-5.
4. Ross, W.M., A.J. Casady, J.R. Lawless, and F.L. Barnett. 1972. Registration of 29 sorghum parental lines. *Crop Sci.* 12:722.
 5. ———, H.J. Gorz, F.A. Haskins, and O.J. Webster. 1980. Registration of ten sorghum parental lines. *Crop Sci.* 20:834.
 6. Tarumoto, I. 1981. Comparison of hybrid seed production in sterile single crosses and male-sterile lines. *Sorghum Newsl.* 24:24-25.
 7. Webster, O.J., P.T. Nordquist, and L.V. Peters. 1977. Registration of eight sorghum parental lines. *Crop Sci.* 17:191.