University of Nebraska - Lincoln
DigitalCommons@University of Nebraska - Lincoln

Agronomy & Horticulture -- Faculty Publications | Agronomy and Horticulture Department

11-1984

Comparison of F_1's and Inbreds as Female Parents for Sorghum-Sudangrass Seed Production

Herman J. Gorz
United States Department of Agriculture

J. J. Toy
University of Nebraska-Lincoln, John.Toy@ars.usda.gov

Francis A. Haskins
University of Nebraska - Lincoln, fhaskins@neb.rr.com

W. M. Ross
United States Department of Agriculture

Follow this and additional works at: http://digitalcommons.unl.edu/agronomyfacpub

 Part of the Plant Sciences Commons

Gorz, Herman J.; Toy, J. J.; Haskins, Francis A.; and Ross, W. M., "Comparison of F_1's and Inbreds as Female Parents for Sorghum-Sudangrass Seed Production" (1984). *Agronomy & Horticulture -- Faculty Publications*. 268.
http://digitalcommons.unl.edu/agronomyfacpub/268

This Article is brought to you for free and open access by the Agronomy and Horticulture Department at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Agronomy & Horticulture -- Faculty Publications by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

Published in Crop Science (November-December 1984) v.24, no. 6

Comparison of F_1's and Inbreds as Female Parents for Sorghum-Sudangrass Seed Production[1]

H. J. Gorz, J. J. Toy, F. A. Haskins, and W. M. Ross[2]

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 F_1's with their component A-lines. The F_1'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 F_1's in Study 1 and seven groups of six F_1's in Study 2 were compared with their respective A-lines. All groups of F_1'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 F_1's in both studies, as were the correlations of yield and threshing percentage except for the F_1'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 F_1'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 F_1'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 F_1 male steriles were greater and production was more dependable than for A-lines because the F_1'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 F_1's and six sorgo male-sterile F_1's were used in a comparative study of seed production of forage sorghum hybrids. Seed weight per head on the grain-sorghum male-sterile F_1's was slightly lower than for the A-lines, while seed weight per head on the sorgo male-sterile F_1'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 F_1'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 F_1 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 (F_1'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 F_1'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 F_1 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-

[1] Contribution of USDA-ARS and the Nebraska Agric. Exp. Stn. Published as Paper no. 7415, Journal Series, Nebraska Agric. Exp. Stn., Lincoln. Research was conducted under Nebraska Project no. 12-114. Received 29 Feb. 1984.

[2] Supervisory research geneticist, USDA-ARS; research technologist in agronomy; George Holmes professor of agronomy; and research geneticist, USDA-ARS, Lincoln, NE 68583, respectively.

Published in Crop Science (November-December 1984) v.24, no. 6

Table 1. Means and coefficients of variation (C.V.) for nine traits of A- × B-line F_1'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 F_1's and within A-lines, and for F_1'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 F_1's, A-lines, and F_1's vs. A-lines. The F_1'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 F_1's for all characters in both studies except threshing percentage among F_1's in Study 1 and germination at 10 and 25°C among A-lines in Study 2 (Table 1). Differences between A-lines and F_1's also were significant for all traits except panicles per plant in both studies and 100-seed weight in Study 2. F_1'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. F_1's also yielded 45 and 82% more grain than their A-line counterparts in Study 1 and 2, respectively. The yield increase of the F_1'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 F_1'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 F_1 hybrids outyielded the A-lines by 54%, with the F_1'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 F_1's having a common A-line were compared with their respective A-line values (Table 2). All groups of F_1'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 F_1's contributed most to the yield advantage of the F_1's. In many of the comparisons, F_1's also were significantly taller and earlier in maturity, and had significantly higher germination percentages. Differences between F_1'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 F_1'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 F_1's in Study 1. Other significant correlations in the F_1'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 F_1's and A-lines in Study 1. In the F_1'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 F_1's and A-lines in these experiments revealed that there was an association of yield in A-lines and the F_1'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 F_1'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 F_1's while appearing in 6 of the lowest yielding F_1's. In Study 2, a closer relationship existed between yield in A-lines and F_1'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 F_1's. The three lowest yielding A-lines, KS9, N48, and Redlan, were represented 13 times among the 10 lowest yielding F_1's.

Table 2. Means of nine traits in sets of A- × B-line F_1'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‡	Germination 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 F_1'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
		0.04	0.22	−0.05	−0.06	0.20	0.20
Height, cm	−0.19		−0.17	−0.30	−0.38*	0.23	0.01
	0.27		−0.04	−0.04	−0.68*	0.25	0.03
Yield, kg ha^{-1}	−0.39	0.52*		−0.27	0.50**	0.72**	0.23
	−0.45	0.35		0.20	0.33	0.77*	0.90**
100-seed weight, g	0.13	0.03	0.13		−0.18	−0.57**	0.06
	0.08	−0.30	−0.08		−0.03	−0.33	0.23
Panicles/plant, no.	−0.31	0.26	0.28	−0.40		0.14	−0.01
	−0.15	−0.43	0.21	−0.31		0.00	0.37
Seeds/panicle, no.	−0.27	0.49*	0.76**	−0.09	−0.12		0.10
	−0.51	0.60	0.86**	−0.34	−0.11		0.62
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 F_1's and 7 for A-lines in Study 1; 19 for F_1's and 5 for A-lines in Study 2.

The seed yield of F_1 male-steriles was superior to that of their A-line counterparts in both studies, and the earlier maturity of the F_1 hybrids may reduce the need for seed drying. Also, additional progress in the development and use of improved F_1 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 F_1's to use and the magnitude of their superiority over A-lines will be influenced by the location in which seed is produced.

REFERENCES

1. Harvey, P.H. 1977. Sorghum germplasm base in the U. S. Corn and Sorghum Res. Conf., Proc. 32:186–198.
2. Hookstra, G.H., and W.M. Ross. 1982. Comparison of F_1's and inbreds as female parents for hybrid sorghum seed production. Crop Sci. 22:147–150.
3. 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.