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J. White

K. Bolsen

B. Kirch

See next page for additional authors

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Selecting forage sorghum cultivars for silage

Authors

J. White, K. Bolsen, B. Kirch, and L. Pfaff

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Selecting Forage Sorghum Cultivars for Silage

Jim White, Keith Bolsen,
Brett Kirch, and Lyle Pfaff

Summary

Eighty forage sorghum cultivars were compared in 1986 for agronomic and silage quality traits. Silage yield ranged from 5.3 to 10.0 tons (t) of dry matter (DM) per acre (mean, 7.4 t); grain yield, from 13 to 113 bushels (bu) per acre (mean, 66 bu). Percent lodging was extremely high, with a mean of 51% and only one cultivar free of lodging. Pre-ensiled DM content ranged from 22.2 to 35.4% (mean, 27.4%) and plant height from 85 to 180 inches (mean, 121 inches). Silage quality results showed that in vitro DM digestibility ranged from 44.6 to 62.1% (mean, 53%); crude protein from 4.5 to 8.2% (mean, 6.8%); neutral detergent fiber from 48.3 to 71.9% (mean, 58.4%); and acid detergent fiber from 27.1 to 49.8% (mean, 35.7%).

From the 80 cultivars in 1986, 60 were selected for the 1987 trial. When compared to 1986, the 1987 means showed slightly lower silage (7.0 t) and grain (63 bu) yields and much shorter plants (93 inches). Lodging scores were dramatically lower in 1987 (10%), and DM content was higher (29.1%). The year to year effect influenced all of the agronomic traits measured. The 1986 growing season favored the early maturing forage sorghums, whereas 1987 favored the late maturing cultivars.

Introduction

Results of a 1986 Kansas State University survey of sorghum seed dealers indicated that there were more than 100 forage sorghum cultivars available in Kansas.

Prior to the interest in hybrid sorghum in the late 1950's, nearly all commercially grown forage sorghum could be traced to less than 20 introductions. Improved cultivars have been developed from a rather narrow germplasm base, with 50 to 60% of the sorghum currently grown in the United States having similar germplasm. Although two forage sorghum cultivars might have similar germplasm and appearance, their value as silage crops could be distinctly different.

Often cultivar recommendations and/or selections are made primarily on the basis of agronomic traits (i.e., silage yield, lodging score). Although silage yield is an important criterion, it is only a part of the silage resource, and it may not be the most important. A producer could be most interested in maximum silage yield for over-wintering cows. However, for backgrounding cattle, a producer would be interested in the most economical feed cost per pound of gain and, thus, silage quality would also be an essential criterion. Choice of a forage sorghum cultivar should be based upon a number of traits, including yield potential of forage and grain, adaptation, handling and ensiling characteristics, and feeding value of the silage.

Within the forage sorghum complex there is tremendous biological variation. Our objective was to provide documentation for the agronomic and silage quality traits of many of the forage sorghum cultivars available in 1986 and 1987.

Experimental Procedures

Trial 1: 1986. From the available forage sorghum cultivars identified in the 1986 survey, 80 were selected for use in Trial 1. The selections represented a broad range of agronomic characteristics.

The cultivars were grown under dryland conditions on a silt loam soil near the Kansas State University campus in Manhattan. The plots were planted on June 4. One month earlier, 100 lb/acre of anhydrous ammonia was applied. A soil test indicated that phosphorus and potassium were adequate. Furdan 15G[®] insecticide was applied in the furrow at planting, and the following day Ramrod[®] was used as the pre-emergence herbicide. In July, Cygon 400[®] was used to control greenbugs.

The cultivars were randomly assigned in a block design, each with three replicates. Each plot was 30 ft long and four 30-inch rows wide. All grain-producing cultivars were harvested at the late-dough stage of kernel maturity. The sterile hybrids were harvested when the kernels in the unbagged heads reached the late-dough stage. Nonheading hybrids were harvested on the first frost date (Oct. 15). Before harvest, all plots were reduced to 20 ft in length, and one of the two inside rows was harvested with a modified one-row forage harvester to determine silage yield. The heads from the other inside row were hand-cut, dried, and threshed to measure grain yield. The chopped forage was ensiled in 5-gallon plastic laboratory silos. Silos were opened after 90 days, and samples taken for chemical analyses.

Agronomic data collected for each plot included days to half bloom, plant height, lodging score, silage yield, and grain yield. Silage quality traits measured for each plot included dry matter (DM), crude protein (CP), in vitro DM digestibility (IVDMD), neutral detergent fiber (NDF), and acid detergent fiber (ADF).

Trial 2: 1987. From the 80 cultivars used in Trial 1, 60 were selected to use in a similar study in 1987. The plots were planted six rows wide (rather than four) and silage yield was measured by harvesting two inside rows (rather than one). All agronomic and silage data were collected by the methods used in Trial 1.

Results and Discussion

Presented in Table 44.1 are the agronomic and silage quality results of Trial 1 and agronomic results of Trial 2. For certain categories, five cultivars are identified as being extreme high and low observations.

Trial 1: 1986. Silage DM yield ranged from 5.2 to 10.0 tons per acre, with an average of 7.4 tons. The cultivar with the highest yield was Funk's G 1990; the lowest was the variety, Ellis. Other high yielding cultivars were PAG 55F (9.9 t), Golden Harvest (GH) SI Gro 3 (9.6 t), Garrison Sile-all (9.3 t), and DeKalb FS1a+ (9.2

t). Low yielding cultivars were Casterline Suline (6.0 t), Warner Sweet Bee Sterile (6.0 t), Ketgen KFS-2 (5.7 t), and Triumph SSII (5.6 t).

Grain yield (not determined for the 11 sterile or nonheading hybrids) ranged from 12 to 113 bu per acre, with an average of 66 bushels. The highest yielding cultivar was Golden Acres (GA)-TE Silomaker; the lowest was Northrup King (NK) Sucrosorgo 405. Other high yielding cultivars were Cargill 200F (106 bu), DeKalb FS-5 (92 bu), Pioneer 947 (89 bu), and Pioneer 927 (89 bu). Other low yielding cultivars were PAG 466 (35 bu), Oro Red Top Kandy (30 bu), and Hoegemeyer 615F (27 bu).

Days to half bloom ranged from 53 to 106, with an average of 71 days. The earliest cultivar was Buffalo Canex; the latest was NK Sucrosorgo 405. Five cultivars bloomed in 55 days or less, and five bloomed after 85 days. Lodging score ranged from 0 to 100%, with an average of 51 percent. Only one hybrid, McCurdy F65, did not have any lodged plants, whereas GA-TE Milkmaker, GA-TE Silomaker, and NK 326 were 100% lodged. Some plots (replicates) were so badly lodged that they were judged to be unharvestable (i.e., rep 1 of Hoegemeyer 615F and rep 2 of Terra Ho-K). Plant height ranged from 85 to 180 inches, with an average of 121 inches. The shortest were DeKalb FSLa+ and the variety, Rox Orange; the tallest was Pioneer 931. Other short cultivars were McCurdy XF65, NK 300, and PAG 455. Other tall cultivars were NK Sucrosorgo 405, Funk's G 1990, Oro Red Top Kandy, and Sokota 320F. Pre-ensiled DM content ranged from 22.2 and 35.4%, with an average of 27.4 percent. The wettest cultivar was Hoegemeyer 615F; the driest was Asgrow H8551. Only seven cultivars contained over 30% DM, and nine contained under 25% DM at harvest.

In vitro DM disappearance ranged from 44.6 to 62.1%, with an average of 53 percent. The hybrid with the highest IVDMD was Cargill 250S (a sterile); the lowest was NK Sucrosorgo 405, which also had the lowest grain yield. Only two other cultivars were 60% digestible or above; Early Sumac and Buffalo Canex; 20 cultivars were less than 50% digestible. Crude protein ranged from 4.5 to 8.2%, with an average of 6.8 percent. The NDF fraction ranged from 48.3 to 71.9%, with an average of 58.4 percent. The ADF fraction ranged from 27.1 to 49.4%, with an average of 35.7 percent. Buffalo Canex had the lowest NDF and second lowest ADF, whereas Pioneer 931 had the highest NDF and ADF fractions.

Results from Trial 1 indicated that the late maturing, nonheading cultivars had the highest silage yields. However, these high yielding cultivars (i.e., Pioneer 931 and Funk's G 1990) tended to have low IVDMD, low protein, and high fiber fractions.

Trial 2: 1987. Silage DM yield ranged from 4.2 to 10.2 tons per acre, with an average of 7.0 tons. The highest yielding cultivar was DeKalb 25E; the lowest was Pioneer 956. Other high yielding cultivars were Funk's G 1990 (9.8 t), GH SI Gro 3 (9.5 t), Pioneer 931 (9.5 t), and Terra Ho-K (9.4 t). Low yielding cultivars were NK Sucrosorgo 301 (5.1 t), Early Sumac (5.0 t), PAG Mor-Cane (4.8 t), and Cargill 200F (4.6 t).

Grain yield ranged from 35 to 112 bushels per acre, with an average of 63 bushels. The highest yielding cultivar was McCurdy XF65; the lowest was the variety, Atlas. Other high grain-yielding cultivars were McCurdy F75A (102 bu), DeKalb 25E (100 bu), Garst 333 (100 bu), and PAG 55F (100 bu). Low grain-yielding cultivars

were Rox Orange (55 bu), NC + 935 (54 bu), Warner 2 Way DR (50 bu), and GH SI Gro 2 (42 bu).

Days to half bloom ranged from 56 to 106 days, with an average of 73 days. The earliest cultivar was NK Sucrosorgo 301; the latest was NK Sucrosorgo 405. Five cultivars bloomed in 59 days or less, and five bloomed on or after 85 days. Lodging score ranged from 0 to 61%, with an average of 10 percent. Several cultivars had no lodged plants, including Atlas, DeKalb FS-5, Funk's G 1990, Keltgen KFS, McCurdy XF65, NK 300, PAG 455, Pioneer 947, and Pioneer 931. The cultivar with the most lodged plants was NK Sucrosorgo 301. Other badly lodged cultivars were Rox Orange (31%), Keltgen (KFS-1 (34%), Hoegemeyer 610F (39%), and Sokota 320F (43%). Plant height ranged from 67 to 143 inches with an average of 93 inches. The shortest was DeKalb FS1a+; the tallest was Pioneer 931. Other short cultivars were NK 300, McCurdy XF65, Keltgen KFS-2, and PAG 55F. Tall cultivars were GH SI Gro 3, Oro Red Top Kandy, Funk's G 1990, and NK Sucrosorgo 405. Pre-ensiled DM content ranged from 24 to 34.8%, with an average of 29.2 percent. The wettest cultivar was PAG Mor-Cane; the driest was Cargill 200F. In contrast to Trial 1, 20 cultivars contained over 30% DM and only two contained under 25% DM at harvest.

Differences Between Years. The 1986 growing season favored early maturing forage sorghums, whereas 1987 favored the late maturing cultivars. In 1987, all cultivars tended to be a few days later in reaching half bloom; however, they matured to the late-dough stage and were harvested earlier than in 1986 (Table 44.2). The last harvest date in 1986 was October 15; in 1987 it was October 7. The average plant height in 1987 was over 2 ft shorter than in 1986 (93 vs. 121 inches). In 1986, the forage sorghums had higher averages for silage yield (7.4 vs. 7.0 t), grain yield (66 vs. 63 bu), and lodging score (51 vs. 10%).

Across years, the late maturing, nonheading cultivars tended to have the highest silage yields; however, they also tended to have the lowest IVDMD, lowest protein, and highest fiber fractions.

Table 44.1. Agronomic and Silage Quality Traits for the 80 Cultivars in Trial 1 and Agronomic Traits for the 60 Cultivars in Trial 2

Cultivar ²	Days to		Plant Ht., Inches	Silage Yield,		Grain Yield,		Pre-ensiled		Lodging		Silage Quality Traits ¹				
	Half Bloom			Tons DM/A.	Bu/A.	DM, %	Score, %	IVDMD, %	CP (% of Silage DM)	NDF (% of Silage DM)	ADF					
	1986	1987	1986	1987	1986	1987	1986	1987	1986	1987	1986	1987	1986			
Agripro 380F	56	60	116	91	7.7	6.2	78	67	27.6	28.5	14	18	59.0	5.7	54.4	31.3
Agripro 905F	79	85	133	104	7.5	7.2	56	74	26.2	32.4	90	8	51.9	6.1	56.4	37.3
Asgrow H8551	0	--	123	--	6.4	--	0	--	35.4	--	80	--	52.9	6.7	61.6	35.9
Atlas	65	64	115	90	6.8	6.0	36	35	26.7	28.8	9	0	54.0	7.0	54.7	32.8
Buffalo Canex	53	57	103	90	6.3	5.3	64	60	25.5	26.9	16	2	60.0	7.9	48.3	27.8
Cargill 200F	56	59	99	79	7.0	4.6	106	73	34.1	34.8	10	14	55.9	7.0	52.9	31.2
Cargill 250S	0	0	100	93	6.1	5.2	0	0	25.7	24.9	33	8	62.1	7.6	57.5	33.1
Cargill SS100	55	--	109	--	7.2	--	66	--	28.0	--	17	--	56.5	7.0	59.9	31.5
Cargill SS110	55	--	110	--	6.3	--	69	--	29.1	--	12	--	51.1	7.3	53.2	33.6
Casterline Silo Plus	80	82	137	102	7.3	7.0	52	78	25.7	32.3	67	7	49.4	5.5	60.1	39.8
Casterline SuCane	57	--	113	--	6.0	--	70	--	25.4	--	85	--	54.3	6.9	56.2	32.5
Casterline SuCane 2	61	62	99	75	6.8	5.7	83	65	27.8	26.8	81	4	55.9	6.0	51.3	28.7
DeKalb 25E	84	79	141	105	7.8	10.2	57	100	25.5	28.5	73	3	47.9	7.5	64.9	40.5
DeKalb FS-1a+	76	65	85	67	9.2	6.2	68	64	29.5	30.2	21	1	52.7	6.9	58.1	34.8
DeKalb FS-5	57	61	111	90	7.9	5.9	92	71	27.7	27.0	1	0	58.1	7.1	53.8	31.6
Early Sunac	58	60	90	79	6.5	5.0	51	57	28.5	26.0	40	16	61.4	7.4	51.1	27.9
Ellis	57	--	96	--	5.3	--	37	--	29.0	--	15	--	59.5	7.5	55.0	30.1
Fontanelle G-307	56	59	113	95	6.3	5.8	63	74	26.6	26.5	35	18	54.6	7.1	52.8	31.5
Funk's FP 4	56	60	111	79	7.0	5.6	68	65	26.7	28.2	8	17	49.8	8.0	56.8	35.2
Funk's G 102F	73	76	111	93	7.4	8.0	86	89	25.6	26.5	91	5	47.3	6.2	62.8	38.1
Funk's G 1990	0	0	161	141	10.0	9.8	0	0	29.6	28.5	4	0	45.8	4.7	66.5	46.2
Funk's 83F	55	--	115	--	6.9	--	49	--	26.3	--	49	--	52.1	8.2	57.2	35.8
GA T-E Goldmaker	0	0	111	93	6.9	6.0	0	0	25.7	27.4	11	9	56.0	7.3	60.3	37.0
GA T-E Milkmaker	85	--	138	--	6.7	--	24	--	23.9	--	100	--	48.2	5.8	62.2	41.7
GA T-E Silomaker	83	75	115	87	9.2	7.9	113	89	26.8	28.1	100	2	48.4	6.3	68.2	37.3
GA T-E Yieldmaker	82	87	108	97	7.9	8.0	75	82	25.6	28.9	99	5	49.7	6.8	62.2	40.6
GH Regro II	55	--	112	--	6.6	--	62	--	28.6	--	4	--	53.1	7.5	56.8	34.3
GH SI Gro 1	59	60	99	92	6.5	6.4	83	75	27.6	27.7	10	13	57.8	7.0	53.8	29.1
GH SI Gro 2	83	84	125	83	7.0	5.9	71	42	28.3	32.6	78	5	50.8	6.2	57.8	37.9
GH SI Gro 3	81	82	133	115	9.6	9.5	46	96	28.6	33.0	98	26	53.6	5.3	63.5	43.9
Garrison Site-all	86	78	137	105	9.3	8.2	83	96	25.4	28.0	96	6	50.0	5.7	61.0	37.8
Garst 333	86	81	123	85	8.3	8.0	83	100	27.9	31.5	69	1	51.6	6.2	59.0	39.3
Grower's 1586F	81	81	108	100	7.5	8.6	72	70	28.5	27.0	84	15	47.6	5.9	64.9	40.6
Hoegemeyer 610F	55	58	108	92	6.7	6.0	77	73	24.9	27.9	79	39	55.6	8.0	58.5	30.4
Hoegemeyer 612F	0	0	104	87	6.6	5.4	0	0	26.6	26.9	5	2	54.6	7.5	60.2	35.5
Hoegemeyer 615F	81	--	124	--	7.3	--	27	--	22.2	--	97	--	45.1	5.1	63.6	39.5
Hoegemeyer 618F	87	77	140	107	8.6	8.4	58	80	27.2	26.7	95	28	50.4	4.8	39.2	37.7
Horizon F12	58	61	111	90	7.7	5.5	81	63	28.8	28.8	19	2	--	7.7	50.3	28.0
Keltgen KFS	80	76	120	83	7.5	7.0	64	63	27.8	28.5	77	0	45.8	6.0	59.7	40.0
Keltgen KFS1	55	57	112	101	7.0	6.5	87	83	26.7	29.7	71	34	53.6	7.0	56.2	32.7
Keltgen KFS2	0	--	103	--	5.7	--	0	--	26.5	--	12	--	55.3	6.2	56.5	35.3
McCurdy F75A	82	73	113	97	8.3	8.0	84	102	27.4	28.3	93	9	51.4	6.3	64.6	40.9
McCurdy F65	80	69	86	69	7.1	7.5	82	112	29.2	32.6	0	0	47.8	7.2	54.9	35.4
McCurdy F69	87	84	121	86	7.7	5.9	71	57	29.0	30.2	66	3	52.1	5.1	58.9	37.4
McCurdy F79	81	--	135	--	7.4	--	36	--	27.5	--	92	--	51.3	5.9	59.6	39.8
NB 305F	59	60	102	85	8.0	7.0	79	83	28.5	30.9	5	7	59.4	7.1	50.0	29.4
NC+ 935	60	63	117	97	7.9	6.1	81	54	27.8	25.9	78	1	57.9	6.3	55.2	33.0
NC+ 965	78	--	137	--	8.5	--	66	--	27.0	--	79	--	--	--	--	--
NK 300	81	71	86	68	8.0	7.0	82	79	30.9	32.2	2	0	46.2	6.3	64.7	37.4
NK 326	77	--	120	--	6.7	--	43	--	24.9	--	100	--	57.4	5.1	61.2	39.6
NK SucroSorgo 301	53	56	108	92	6.3	5.1	76	81	25.6	29.7	58	61	56.5	7.2	57.6	29.7
NK SucroSorgo 405	106	106	169	141	7.0	8.8	0	0	28.1	29.1	40	1	44.6	5.1	63.7	42.3
Oro Kandy Kane	58	61	102	89	7.5	6.5	71	73	28.1	29.4	19	6	61.8	7.2	50.8	28.1
Oro Red Top Kandy	84	83	148	119	7.0	7.6	30	76	24.0	29.1	86	1	51.8	6.1	62.6	40.8
PAG 55F	82	84	112	75	9.9	8.9	74	100	28.9	33.8	49	3	51.9	8.1	56.2	37.0
PAG 455	84	77	95	78	8.6	7.8	87	78	27.6	29.9	64	0	45.7	6.9	63.7	37.6
PAG 466	86	--	142	--	7.6	--	35	--	26.9	--	84	--	49.7	6.6	61.2	40.4
PAG Mor-Cane	0	0	101	84	6.2	4.8	0	0	25.3	24.0	11	13	58.2	7.7	54.0	32.2
Pioneer 927	83	84	105	78	8.9	6.3	89	62	26.8	31.8	78	14	53.5	6.2	60.8	37.6
Pioneer 931	0	0	180	144	8.9	9.5	0	0	31.4	33.2	24	0	45.5	5.0	71.9	49.4
Pioneer 947	59	63	116	85	7.6	6.4	89	68	34.4	33.7	28	0	57.2	8.0	50.4	29.0
Pioneer 956	55	59	99	83	6.3	4.2	86	69	30.9	32.7	70	17	60.0	7.2	57.7	31.0
Rox Orange	58	60	85	79	6.4	5.5	72	55	27.6	26.8	21	31	57.5	7.0	52.9	27.1
Seed Tech III-Ton	61	62	115	98	6.8	6.8	67	59	28.2	30.2	27	5	57.7	7.3	54.1	30.3
Seed Tech III-Energy2	80	80	108	107	7.5	8.8	55	62	26.9	29.9	32	8	50.1	5.9	55.4	38.1
Sokota 320F	93	89	146	103	8.0	7.4	61	66	25.1	30.7	92	43	46.9	5.1	56.8	39.8
Sokota 325F	80	83	145	110	8.3	9.2	55	65	27.0	28.7	77	6	49.3	6.2	52.2	34.8
Sokota 330F	0	--	101	--	6.2	--	0	--	24.5	--	26	--	57.2	7.4	57.7	35.2
Stauffer 333F	79	79	137	97	8.0	7.7	68	70	27.6	33.4	78	4	52.7	6.3	54.8	37.2
Sugar Drip	67	--	118	--	6.7	--	45	--	25.0	--	87	--	54.5	7.2	57.7	36.2
Terra HO-K	84	78	145	104	8.3	9.4	44	65	27.3	28.9	56	3	50.5	4.5	62.0	39.5
Terra Sterile Honey	0	--	102	--	6.0	--	0	--	24.8	--	4	--	57.6	7.3	57.7	34.6
Triumph SS11	55	--	100	--	5.6	--	--	--	27.4	--	32	--	51.0	7.7	61.1	35.4
Triumph Supersite 20	79	76	137	110	8.5	7.9	58	66	27.2	28.2	43	11	49.3	5.4	65.1	39.8
Triumph Supersite 10	56	--	108	--	6.3	--	37	--	27.7	--	7	--	55.1	7.2	59.5	33.6
Warner 2-WayDR	81	76	123	107	8.3	7.8	80	50	28.1	25.3	74	8	50.0	5.8	65.9	37.4
Warner Sweet Bee	57	76	119	89	6.4	5.3	78	75	24.9	25.3	74	3	55.6	6.2	53.8	32.0
Warner Sweet Bee Ster.	0	0	107	90	6.0	5.5	0	0	23.3	25.1	28	1	55.8	6.9	60.1	37.5
Wilson Forge King	80	75	119	83	8.6	8.7	85	100	27.7	30.7	96	5	51.0	5.8	66.7	38.6
Wilson Green SuS	55	--	127	--	7.1	--	66	--	31.0	--	12	--	51.2	7.3	60.9	37.4

¹IVDMD = in vitro dry matter digestibility, CP = crude protein, NDF = neutral detergent fiber, ADF = acid detergent fiber.²GA = Golden Acres, GH = Golden Harvest, NK = Northrup King.

Table 44.2. Minimum, Maximum, Mean, and Standard Deviation for the Data in Trials 1 and 2

Item	Days to Half Bloom		Plant Ht., Inches		Silage Yield, Tons DM/A		Grain Yield, Bu/A.		Pre-ensiled DM, %		Lodging Score, %		1 Silage Quality Traits					
													IVDMD, CP %	NDF (% of Silage DM)	A D F			
		1986	1987	1986	1987	1986	1987	1986	1987	1986	1987	1986	1987	1986	- - -	1 9 8 6	- - -	
Minimum	53	56	85	67	5.3	4.1	13	35	22.2	24.0	0	0	44.6	4.5	48.3	27.1		
Maximum	106	106	180	143	10.0	10.2	113	112	35.4	34.8	100	61	62.1	8.2	71.9	49.4		
Mean	71	73	121	93	7.4	7.0	66	63	27.4	29.2	51	10	53.0	6.8	58.4	35.7		
Std. Dev.	14	12	17	17	1.0	1.5	20	29	2.0	2.5	35	12	4.4	1.6	4.8	4.5		

1

IVDMD = in vitro dry matter digestibility, CP = crude protein, NDF = neutral detergent fiber, ADF = acid detergent fiber.



Small experimental forage harvester used for harvesting forage plots and measuring their production.