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Relationship between Agronomic and Silage Quality Traits of Forage Sorghum Cultivars

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Summary

Results from two trials evaluating 11 forage sorghums as silage crops indicated that silage quality traits of voluntary intake, digestibility, and crude protein content were linearly associated with the agronomic characteristics of days to half bloom and plant height. Intake was negatively associated with plant height (r = -.49); digestibility was negatively associated with days to half bloom (r = -.39) and plant height (r = -.49); and crude protein was negatively associated with days to half bloom (r = -.51) and plant height (r = -.71). Within the same cultivar, but between years, voluntary intake varied by as much as 30 percent, digestibility by 13 percent, and protein content by 12.5 percent. Forage sorghums were also compared to grain sorghum and corn hybrids.

Introduction

Historically, Kansas has been the leading state in the production of forage sorghum. Producers who grow their own forage sorghum tend to select cultivars based upon agronomic traits, such as tonnage yield or resistance to lodging. The feeding value of these silages depends upon the management of the crop when ensiled and silage quality factors, such as voluntary intake, digestibility, and crude protein and fiber content. The objectives of this study were (1) to determine the associations between selected agronomic and silage quality traits of forage sorghums and (2) to identify those cultivar characteristics that are associated with superior silage. Grain sorghum and corn hybrids were included for comparison.

Experimental Procedures

Trial 1: 1986. Seven forage sorghum and five grain sorghum cultivars were grown in 1986. The forage sorghum cultivars included two early season (Buffalo Canex and Pioneer 956), three mid season (Atlas, DeKalb FS-5, and Pioneer 947), and two late season (Golden Acres T-E Silomaker and DeKalb 25E). The grain sorghums included Funk’s G-522, Pioneer 8493, Asgrow Topaz, NC+ 174, and DeKalb 41Y. Cultivars were selected to represent a cross section of plant height, season length, and grain to forage ratios.

The sorghums were grown under dryland conditions on a silt loam soil near the Kansas State University campus in Manhattan. The plots were planted on May 31. One month earlier, 100 lb/acre of anhydrous ammonia was applied. Soil tests indicated that phosphorus and potassium were adequate. Furdan 15G® insecticide was applied in the furrows at planting, and the following day, Ramrod® was used as the pre-emergence herbicide. In July, Cygon 400® was used to control greenbugs. The sorghums were randomly assigned to plots in a block design, each with three

replicates. Each plot had six rows 30 inches apart and 200 ft long. All plots were harvested when the kernels were in the late-dough stage of maturity. Previous research at Kansas State University (KAES Reports of Progress 494 and 514) has indicated that harvest at that stage optimizes both silage yield and nutritive value of sorghum silages.

Agronomic data collected for each plot included days to half bloom, plant height, and whole-plant DM and grain yields. Days to half bloom (number of days between planting and the date when half of the main heads exhibited some florets) was used to measure season length. Plant height was measured to the tallest point of the head immediately prior to harvest. Lodging score is the number of plants lodged divided by the number of plants in a row. Lodged plants are those with broken stalks or plants inclined less than 45 degrees from the soil surface. Silage yield was determined by harvesting three inside rows of each plot with a Field Queen forage harvester. After harvest, the chopped material was inoculated with Biomate® and ensiled in plastic lined, 55 gallon pilot silos. The silos were stored at ambient temperature for approximately 100 days prior to the intake and digestion trial. The two outside rows were left as borders, and heads were clipped from the remaining row from a random 60 ft to determine grain yield. The heads were dried and threshed with a stationary thresher.

Thirty-six crossbred wether lambs (avg. wt. of 113 lb) were randomly assigned to each silage (three per silage) in a two-period voluntary intake and digestion trial. Each period had a 10-day preliminary phase, a 7-day voluntary intake phase, a 2-day adjustment to 90% of voluntary intake, and a 7-day collection phase. The rations were 90% silage and 10% supplement on a DM basis. All were formulated to 11.5% protein and met NRC requirements for vitamins and minerals. Between the two periods, the lambs were randomly reassigned to the silages.

<u>Trial 2: 1987.</u> Ten forage sorghum cultivars, one grain sorghum hybrid (DeKalb 42Y), and one corn hybrid (Pioneer 3183) were grown at the same field location and under similar practices as the cultivars in Trial 1. The forage sorghums included Pioneer 956 and 947, DeKalb FS-5 and 25E, PAG 455, Funk's G 102F, Golden Acres T-E Silomaker, NK 300, Cargill 200F, and Atlas. The corn plots were planted on May 6, and all sorghum plots were planted on June 3. All agronomic and silage data were collected by methods used in Trial 1. A voluntary intake and digestion trial was carried out following the same procedures as described in Trial 1; however, only the results from the first period are reported.

Results and Discussion

In both Trials the silages appeared to be well preserved, with no off odors or indications of clostridial fermentation. During the feed-out periods, there were no indications that the silages were deteriorating from exposure to air.

Results from Trial 1 are shown in Table 43.1. The grain sorghums consistently yielded less silage DM per acre than did the forage sorghums. However, the grain sorghums had higher crude protein values, voluntary intakes, and DM digestibilities. Within the grain sorghums, there were no statistical differences in voluntary intakes or digestibilities. This is not surprising, considering that commercial grain sorghum

hybrids have been developed almost exclusively using a cytoplasmic male sterile system, with Milo cytoplasm and Kafir restoring genes. At the outset it was anticipated that substantial differences within the grain sorghum hybrids would be found because grain sorghum has not been ruthlessly selected for silage quality criteria. However, because of the consistency found in Trial 1, it was decided that only one grain sorghum would be included as a relative standard with the forage sorghum cultivars in Trial 2.

Results from Trial 2 are shown in Table 43.2 and are preliminary. Data from only one period of the digestion trial are available at this time. The corn silage had disappointingly low grain yield, silage yield, crude protein, and voluntary intake. These results support earlier research indicating that corn silage was superior to sorghum silage only when the environment favored corn production.

The grain sorghum silage in Trial 2 again had higher intake, digestibility, and crude protein than the forage sorghums. Within the forage sorghums, similar extensive variations was found in Trial 2 as had been observed in Trial 1, and the cultivars were influenced by year. The 1986 growing season favored early season cultivars, but 1987 favored late season hybrids. There were also substantial variations in silage quality traits between years. Within a cultivar, intake varied by as much as 30% between years, digestibility by as much as 13%, and protein by as much as 12.5 percent.

Considering the limitations of making and evaluating large numbers of silages, if agronomic traits could be used to predict subsequent silage quality of a cultivar, the selection process would be facilitated. Listed in Table 43.3 are correlations (linear associations) of agronomic traits and silage quality traits.

The results show intake to be negatively correlated (r = -.49) with plant height (i.e., as plant height decreases, intake increases). Dry matter digestibility was negatively correlated to both days to half bloom (r = -.39) and plant height (r = -.49). Crude protein content was negatively correlated with both days to half bloom r =-.51) and plant height (r = -.74). Results indicate that silage DM yield was not statistically correlated with silage quality traits. Hence, to select for improved silage quality, these data suggest starting with short, early season cultivars.

Table 43.1. Agronomic and Silage Quality Traits of the 12 Forage and Grain Sorghum Cultivars in Trial 1

Cultivar	Harvest Date	DHB[1]	Plant Height	Whole-plant[2] DM Yield	Whole-plant[2] DM	Whole-plant[2] CP	Grain Yield[3]	Vol. Intake[4]	DM Dig.[5]
	1986		Inches	Ton/A.	%	%	Bu/A.		%
Forage Sorghum									
Canex	Aug. 20	57	108	5.5	25.3	7.8	51	66.5[abcd]	58.7[bcd]
Pioneer 956	Aug. 20	57	105	6.0	30.5	7.6	93	57.6[cd]	58.0[cd]
Pioneer 947	Sept. 4	61	108	7.3	34.4	7.4	105	61.5[bcd]	58.6[bcd]
DeKalb FS-5	Aug. 30	60	106	6.6	27.9	7.3	87	70.5[ab]	57.7[cd]
DeKalb 25E	Oct. 6	87	131	7.0	27.9	6.6	68	53.3[c]	53.7[e]
Silomaker	Oct. 6	85	112	8.2	30.0	7.4	98	55.9[d]	52.3[e]
Atlas	Sept. 4	64	103	6.9	27.5	7.2	52	54.4[d]	56.8[d]
Grain Sorghum									
Funk's G-522	Aug. 21	51	59	5.6	33.7	9.0	106	68.1[abcd]	60.7[ab]
Pioneer 8493	Aug. 21	51	54	5.2	35.1	9.8	99	69.5[ab]	61.5[ab]
NC + 174	Aug. 23	52	62	5.6	34.0	9.8	106	74.5[ab]	61.4[ab]
Asgrow Topaz	Aug. 26	53	55	5.5	33.6	9.2	113	72.0[ab]	63.8[a]
DeKalb 41Y	Aug. 29	55	51	5.7	33.6	9.2	110	72.5[ab]	61.4[ab]

[1] DHB = days to half bloom.

[2] DM = dry matter and CP = crude protein on a DM basis.

[3] Adjusted to 12.5% moisture.

[4] Voluntary intake expressed as grams of DM per kg of metabolic body weight ($kg^{.75}$).

[5] DM Dig. = dry matter digestibility.

[abcd] Means in a column with different superscripts differ (P<.05).

Table 43.2. Agronomic and Silage Quality Traits of the 12 Forage Sorghum, Grain Sorghum and Corn Cultivars in Trial 2

Cultivar	Harvest Date	DHB[1]	Plant Height	Whole-plant[2] DM Yield	DM	CP	Grain Yield[3]	Vol. Intake[4]	DM Dig.[5]
	1987		Inches	Ton/A	%	%	Bu/A.		%
Forage Sorghum									
Cargill 200F	Aug. 25	59	73	4.9	41.4	8.3	75	63.8	62.8
Pioneer 956	Aug. 25	58	77	4.5	38.1	8.6	72	64.1	56.5
Pioneer 947	Sept. 3	65	75	5.1	33.0	9.4	72	64.7	59.8
DeKalb FS-5	Aug. 28	61	77	4.8	29.4	8.3	69	66.1	59.0
DeKalb 25E	Sept.29	78	88	7.3	30.3	7.5	90	54.6	58.0
Silomaker	Sept 21	77	73	6.3	32.0	8.1	76	79.8	60.1
Atlas	Sept 2	66	73	4.3	27.0	7.9	35	60.9	58.8
Funk's 102F	Sept 24	77	77	6.6	30.7	8.5	92	57.8	59.1
NK 300	Sept 19	71	59	6.0	34.1	8.4	92	72.6	60.8
PAG 455	Sept 24	77	65	7.0	33.4	7.7	94	71.8	59.0
Grain Sorghum									
DeKalb 42Y	Aug 28	59	41	3.8	37.2	9.7	78	74.8	63.9
Corn									
Pioneer 3183	Aug 7	--	81	4.7	35.4	7.7	66	58.0	67.5

[1] DHB = days to half bloom.
[2] DM = dry matter and CP = crude protein on a DM basis.
[3] Adjusted to 12.5% moisture.
[4] Voluntary intake expressed as grams of DM per kg of metabolic body weight ($kg^{.75}$).
[5] DM Dig.= dry matter digestibility.
[a b c d] Means in a column with different superscripts differ (P<.05).

Table 43.3. Linear Associations[1] of Agronomic and Silage Quality Traits in the Two Trials

Silage Trait	Agronomic Trait: Day to Half Bloom	Plant Height	Whole-plant DM Yield	DM	CP	Grain Yield
Voluntary Intake	NS	-.49	NS	NS	NS	NS
DM Digestibility	-.39	-.49	NS	NS	NS	NS
CP Content	-.51	-.74	NS	NS	NS	NS

[1] Correlations significant at P<.05 and NS is not significant.