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Effects of maturity at harvest and cultivar on agronomic performance of forage sorghum and the nutritive value of selected sorghum silages

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EFFECTS OF MATURITY AT HARVEST AND CULTIVAR ON AGRONOMIC PERFORMANCE OF FORAGE SORGHUM AND THE NUTRITIVE VALUE OF SELECTED SORGHUM SILAGES

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Summary

These studies examined the agronomic performance of 20 forage sorghum cultivars, each harvested at three stages of maturity in 1990. Whole-plant dry matter (DM) yields were highest at the late-dough stage of kernel maturity, whereas DM content and grain yields steadily increased as maturity advanced. A voluntary intake and digestion trial was conducted with 12 grain and forage sorghum silages harvested at the late-dough stage in 1989. The highest silage DM intakes and digestibilities were obtained with the high-grain yielding hybrids.

(Key Words: Forage Sorghum, Cultivar, Maturity, Intake, Digestibility.)

Introduction

Several earlier studies on the effects of stage of maturity showed that harvesting forage sorghums at the late-dough stage optimized silage yields and nutritive values. The objectives of this study were: 1) to document the effect of stage of maturity on agronomic performance over a wider range of forage sorghum phenotypes than was used in previous studies and 2) to continue to compare voluntary intake and DM digestibility of selected forage sorghum silages harvested in the late-dough stage.

Experimental Procedures

1990. Twenty forage sorghum cultivars were selected to represent a broad range of phenotypic characteristics and season lengths. All were grown under dryland conditions near the Kansas State University campus, Manhattan.

The 12-row plots were planted on June 4, and each cultivar was randomly assigned to three replications. Rows were 25 ft long with a 30-inch spacing, and plots were thinned to uniform stands of 34,800 plants per acre. Cultivars were harvested at milk, late-dough, and hard-grain stages of kernel maturity. Agronomic data collected included days to half-bloom, plant height, lodging score, and whole-plant DM and grain yields. The first row in each plot was a border, and whole-plant DM yield for the first maturity stage was measured by harvesting the 2nd and 3rd rows with a precision chopper. All heads in the 4th row were clipped for grain yield determination. The plants in the 4th row were left standing to act as a border for the next harvest.

1989. A voluntary intake and digestion trial was conducted with 12 grain and forage sorghum silages produced in 1989. The cultivars were grown under dryland conditions and harvested in the late-dough stage. Three mature wethers were assigned to each silage in the two-period trial.

The farm-scale plots were similar to those described last year (Rep. of Prog. 592; pp. 110-113). However, dry soil conditions at planting on May 31 and subsequent very low rainfall until the second week in August (only 4.5 inches) produced thin and uneven stands, and one of the three replications for each cultivar was abandoned. Therefore, statistical analysis of the agronomic data shown in Table 4 is not reported, and the numerical values are presented for reference purposes only.

Results and Discussion

1990. Agronomic characteristics of the 20 forage sorghums are shown in Table 1. Blooming was delayed in all cultivars probably because of prolonged cool weather in the early part of the growing season. Time to half-bloom ranged from 64 to 83 days. Plant height varied greatly between cultivars and, as expected, the late-season hybrids were the tallest.

In the milk stage harvest, the only significant lodging occurred in three of the late-season hybrids (i.e., DeKalb FS25E, Garst 333, and SeedTec Hi-Energy II). However, several other cultivars lodged with advancing maturity (i.e., Funk's 102F, Golden Acres T-E Silomaker, Oro Kandy Kane, NC + 940, Pioneer 843 and 947, and Rox Orange). A very high wind on August 30th caused the initial lodging, which appeared to be more severe for the higher grain-yielding hybrids. Plant height did not show a direct relationship to lodging; some of the shorter cultivars had high lodging scores (i.e., Funk's 102F, Silomaker, and Rox Orange), whereas several of the taller sorghums had very low lodging scores (i.e., Atlas, DeKalb FS5 and FS25E, NC+ NB305, and Pioneer 931).

The effects of cultivar and harvest stage on DM content and silage and grain yields of the 20 forage sorghums are presented in Tables 2 and 3. Very high rainfall (13.1 inches) from mid-July through August favored extended vegetative growth in the mid- and late-season hybrids, which resulted in higher whole-plant DM yields, particularly at the first two harvest stages, compared to the early-season sorghums. Limited rainfall

during June and early-July resulted in relatively low whole-plant DM and grain yields for the early-season cultivars at the milk stage harvest (i.e., Buffalo Canex, Cargill 200F, Oro Kandy Kane, and Rox Orange). Whole-plant DM yields peaked at the late-dough stage; however, grain yields continued to increase and were highest at the hard-grain harvest. Eighteen of the 20 cultivars had their highest whole-plant DM yield at the late-dough stage and 14 of the 18 grain-producing sorghums had their highest grain yield at the hard-grain stage. The average harvest intervals were 12 days between the milk and late-dough and 13 days between the late-dough and hard-grain stages.

1989. Agronomic characteristics and results of the voluntary intake and digestion trial are shown in Table 4. Dry matter intake was positively associated with DM digestibility, and the highest digestibilities were obtained for the high grain-yielding cultivars. Six of the 10 grain-producing forage sorghums had not reached the late-dough stage at the first frost on September 24. The non-heading forage sorghum (Funk's G 1990) showed the lowest DM intake and digestibility, which is consistent with previous results for this cultivar.

1989 vs. 1990. Presented in Table 5 are minimum, maximum, and mean values for the agronomic characteristics of the 10 forage sorghum cultivars that were included in both the 1989 and 1990 late-dough stage harvests. Agronomic measurements were dramatically reduced in the 1989 growing season compared to 1990 (i.e., plant height and silage and grain yields).

Table 1. Agronomic Characteristics of 20 Forage Sorghum Cultivars, 1990

Cultivar ¹	Days to half-bloom ²	Plant height, ² inches	Date of the milk stage harvest	Lodging scores, %		
				Milk stage	Late-dough stage	Hard-grain stage
AgriPro 1020F	79	75	Sept 6	-	1	12
Atlas	75	122	Sept 4	-	-	1
Buffalo Canex	64	109	Aug 26	-	-	-
Cargill 200F	67	108	Aug 26	-	-	1
Cargill 466	82	102	Sept 11	5	3	57
Cargill Morcane	-	104	Aug 29	-	-	-
DeKalb FS5	72	122	Sept 3	-	5	8
DeKalb FS25E	83	127	Sept 11	12	18	10
Funk's 102F	80	95	Sept 8	4	30	49
Garst 333	81	110	Sept 7	27	58	79
GA T-E Silomaker	80	95	Sept 7	4	13	74
NC+ NB305	69	118	Aug 28	-	4	2
NC+ 940	69	124	Aug 31	-	14	18
NK 300	79	78	Sept 6	-	3	11
Oro Kandy Kane	65	104	Aug 28	-	18	22
Pioneer 843	74	126	Sept 3	2	13	21
Pioneer 931	-	172	Sept 11	1	-	3
Pioneer 947	73	117	Sept 3	-	54	76
Rox Orange	65	95	Aug 26	-	45	53
ST Hi-Energy II	80	122	Sept 7	60	28	66
Average	74.3	111.3	Sept 3	6	15	28
LSD (P< .05) ³	--	4.2	--	--	--	--

¹GA = Golden Acres; NK = Northrup King; ST = Seed Tec.

²Average of measurements taken at the first two stages of maturity.

³Least significant difference.

Table 2. Dry Matter Content and Silage and Grain Yields of 20 Forage Sorghum Cultivars Harvested at Three Stages of Maturity, 1990

Cultivar	Harvest stage								
	Milk			Late-dough			Hard-grain		
	Whole-plant DM and DM yield, %	Grain yield, T/A ¹	Grain yield, Bu/A ²	Whole-plant DM and DM yield, %	Grain yield, T/A	Grain yield, Bu/A	Whole-plant DM and DM yield, %	Grain yield, T/A	Grain yield, Bu/A
AgriPro 1020F	25.3	5.5	66	31.0	6.8	114	38.7	5.9	119
Atlas	25.3	6.0	41	27.8	7.3	58	28.5	5.7	65
Buffalo Canex	25.1	5.3	17	28.5	6.1	47	31.1	5.7	72
Cargill 200F	28.3	4.7	16	37.6	5.8	72	42.9	6.1	89
Cargill 466	22.6	6.8	61	26.2	7.8	124	32.7	6.6	121
Cargill Morcane	23.7	4.3	-	26.4	5.8	-	27.8	6.1	-
DeKalb FS5	24.8	5.4	58	30.2	7.9	87	34.0	7.2	82
DeKalb FS25E	25.1	7.5	49	27.1	8.2	82	29.9	6.2	107
Funk's 102F	22.4	6.0	54	28.2	7.8	106	33.8	5.9	126
Garst 333	27.3	5.8	39	32.8	8.4	110	37.4	6.3	114
GA T-E Silomaker	24.4	6.4	46	29.0	7.8	96	41.1	6.5	151
NC + NB305	23.1	5.4	23	29.3	7.1	55	30.8	6.3	65
NC + 940	24.7	5.8	40	29.5	7.2	85	31.7	6.3	97
NK 300	24.4	5.8	60	33.9	7.4	105	35.9	6.0	117
Oro Kandy Kane	24.1	4.9	24	30.4	6.9	93	32.7	5.4	92
Pioneer 843	31.4	5.1	45	40.0	8.0	74	38.8	5.6	72
Pioneer 931	32.7	8.3	-	34.3	6.3	-	38.3	6.1	-
Pioneer 947	30.8	4.6	48	43.0	8.3	119	45.7	6.3	133
Rox Orange	22.0	4.5	18	27.2	5.7	83	33.0	5.4	93
ST Hi-Energy II	25.1	7.5	51	24.5	7.2	96	29.5	6.1	112
LSD ³ (P< .05)	--	1.0	13.4	--	1.1	27.0	--	.8	23.8

¹Tons per acre.

²Bushels per acre; adjusted to 14.5% moisture.

³Least significant difference.

Table 3. Effect of Harvest Stage on Dry Matter Content and Silage and Grain Yields of 20 Forage Sorghum Cultivars, 1990

Item	Harvest stage		
	Milk	Late-dough	Hard-grain
Whole-plant DM, %	25.6 ^c	30.8 ^b	34.7 ^a
Whole-plant DM yield, tons/acre	5.8 ^b	7.2 ^a	6.1 ^b
Grain yield, bushels/acre ^{1,2}	42 ^c	90 ^b	102 ^a

^{abc}Means in the same row with different superscripts differ significantly (P< .05).

¹Average of the 18 grain-producing cultivars.

²Adjusted to 14.5 % moisture.

Table 4. Agronomic Characteristics, Dry Matter Content, Voluntary Intake, and Digestibility of 12 Sorghum Silages, 1989

Cultivar	Days to half-bloom	Plant height, inches	Silage DM, %	Whole-plant DM yield, T/A ¹	Grain yield, Bu/A ²	Ration ³	
						DM intake, g/MBW ⁴	DM digestibility, %
<u>Grain sorghum</u>							
DeKalb 42Y	66	37	37.6	3.9	92*	71.0	61.2
<u>Forage sorghum</u>							
DeKalb FS5	73	73	30.4	6.0	98*	69.9	56.8
DeKalb FS25E	103	91	27.8	6.2	34***	67.0	55.7
Funk's 102F	92	76	30.2	5.7	60**	72.8	58.2
Funk's G 1990	--	114	25.6	5.8	--	57.6	55.2
Garst 333	96	77	28.6	5.5	34***	63.7	57.0
GA T-E Silomaker	92	70	29.6	5.8	46**	62.5	52.7
NK 300	89	58	30.9	5.5	77**	67.2	58.9
Oro Kandy Kane	67	61	33.3	4.5	77*	77.5	59.2
Pioneer 947	75	73	33.3	5.6	91*	67.2	58.2
Rox Orange	67	57	31.6	3.7	74*	66.2	55.8
ST Hi-Energy II	92	89	28.6	6.2	43**	63.6	55.6
LSD (P< .05)	--	--	--	--	--	11.4	5.0

¹Tons per acre.

²Bushels per acre; adjusted to 14.5% moisture.

³Ration = 90% silage and 10% supplement on a DM basis.

⁴MBW = metabolic body wt (kg^{.75}).

*Cultivars that were between the late-dough and hard-grain stages at the first frost on Sept 24.

**Hybrids that were in the mid-to-late milk stage at the first frost.

***Hybrids that were in the early-milk stage at the first frost.

Table 5. Minimum, Maximum, and Mean for the Agronomic Characteristics of 10 Forage Sorghum Cultivars Compared in Both 1989 and 1990

Item	Minimum		Maximum		Mean	
	1989	1990	1989	1990	1989	1990
Days to half-bloom	67	65	103	83	85	76
Plant height, inches	57	78	91	127	84	107
Lodging score, %	0	3	9	58	3	27
Silage yield, tons of DM/acre	3.7	5.7	6.2	8.4	5.47	7.56
Grain yield, bu/acre ¹	34	82	98	119	63	98
Whole-plant DM, %	27.8	24.5	33.3	43.0	30.4	30.6

¹Adjusted to 14.5% moisture.