Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 1 *Cattleman's Day (1993-2014)*

Article 1021

1986

Effect of maturity at harvest on yield and composition of hybrid grain and forage sorghum silages

R. Smith

K. Bolsen

T. Walter

B. Kirch

Effect of maturity at harvest on yield and composition of hybrid grain and forage sorghum silages

Abstract

Results from two trials indicate that grain sorghums can produce high, whole-crop dry matter yields in a short time. Although grain sorghum whole-crop silage may yield less tonnage than forage sorghum, its higher crude protein and grain-to-forage ratio could more than compensate for the difference. Maximum yields, both whole-crop and grain, were obtained at late-dough maturity in both years. However, since high quality silages were made at each harvest stage, grain sorghums had a relatively long harvest season. Grain sorghums had a dry matter content suitable for ensiling over the range of maturities studied. In addition, their yield and nutrient content reached a plateau at the late-dough and hard-grain stages.

Keywords

Cattlemen's Day, 1986; Kansas Agricultural Experiment Station contribution; no. 86-320-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 494; Beef; Maturity; Yield; Hybrid grain; Forage sorghum silages

Effect of Maturity at Harvest on Yield and Composition of Hybrid Grain and Forage Sorghum Silages

Russell Smith, Keith Bolsen,
Ted Walter[1], and Brett Kirch

Summary

Results from two trials indicate that grain sorghums can produce high, whole-crop dry matter yields in a short time. Although grain sorghum whole-crop silage may yield less tonnage than forage sorghum, its higher crude protein and grain-to-forage ratio could more than compensate for the difference. Maximum yields, both whole-crop and grain, were obtained at late-dough maturity in both years. However, since high quality silages were made at each harvest stage, grain sorghums had a relatively long harvest season. Grain sorghums had a dry matter content suitable for ensiling over the range of maturities studied. In addition, their yield and nutrient content reached a plateau at the late-dough and hard-grain stages.

Introduction

The importance of sorghum as a feed grain and silage crop in the High Plains region has increased steadily during the past 25 years. Sorghums have more drought resistance or avoidance and better drought recovery than corn. However, there is wide diversity among sorghum types and among hybrids within types for both quantity and quality of silage.

The objective of these experiments was to determine how stage of maturity influences yield, composition, and quality of sorghum hybrids harvested for silage.

Experimental Procedures

Trial 1. Preliminary results were presented last year (Report of Progress 470). Field plots were established on June 1, 1984 under dryland conditions near Manhattan. Treatments were arranged in a split-plot design with four replications. Main plots were three stages of kernel development at harvest: late-milk to early-dough, late-dough, and hard-grain. Subplots were five grain sorghum hybrids: Asgrow Colt, DeKalb DK-42Y, Funk's G-522DR, Northrup-King 2778, TX 2752 x TX 430, and one forage sorghum hybrid (Pioneer 947) for comparison. Procedures for the selection of hybrids, seeding rates, thinning of plots, and collection of agronomic data were similar to those in Trial 2. The chopped material from each subplot was collected and ensiled in a 5-gallon, plastic laboratory silo, using the procedures described on page 110 of this report. Silos were opened about 100 days post-filling and samples were taken for analyses.

---

[1]Department of Agronomy.

Trial 2. Dryland grain sorghum field plots were established in the summer of 1985. One early- (WAC 652G), two intermediate- (DeKalb DK-42Y and NC+ 174), and one late-maturity (Asgrow Colt) hybrids were used. They were chosen to represent a range of sorghum pedigrees, which included variation in maturity, plant height, and forage and grain yields. Each hybrid was harvested at three stages of kernel development: late-milk to early-dough, late-dough, and hard-grain. Treatments were arranged in a split-plot design with stages of harvest as main plots and hybrids as subplots, with four replications.

About 100 lb per acre of anhydrous ammonia and a broadcast pre-emergence herbicide (Ramrod-Atrazine) were applied before planting. All plots were planted on June 13. Two to 3 weeks after emergence, the plots were thinned to 34,848 plants per acre (6 inches between plants). On July 24, Lorsban insecticide spray was applied for greenbug control. Each plot had six rows, 30 inches apart and 30 ft long.

Agronomic data collected for each plot included days to half bloom, plant height, lodging, whole-plant dry matter (DM), and grain yields. Days to half bloom was used to measure maturity. This is defined as the number of days between planting and the date half the main heads exhibited some florets. Plant height was measured to the tallest point of the head immediately prior to harvest. Whole-crop DM yields were determined by harvesting 20 ft from each of the two center rows. All rows were harvested using a modified one-row forage harvester. Chopped forage from each plot was weighed, sampled, and collected for making silage. Grain yields were determined by hand-cutting the heads from 20 ft of one of the remaining rows. The heads were dried and threshed in a stationary thresher.

Results

Trial 1. Differences among grain sorghum hybrids in days to half bloom and plant height were smaller than expected (Table 40.1). This probably resulted from drought and heat during the early part of the growing season. Hot weather during the late growing season accelerated maturity for all the hybrids. On the average, only 9 days elapsed between successive harvest stages. The forage sorghum (Pioneer 947) was significantly later maturing and taller than the grain sorghums. Data for the five grain sorghum hybrids were pooled for statistical analyses and presentation since they responded similarly.

The effect of harvest stage on yields is presented in Table 40.2. The highest ($P<.05$) whole-crop DM and grain yields for the grain sorghums occurred at the late-dough stage. Whole-crop DM yields for all five hybrids and grain yields for three of the five hybrids decreased at the hard-grain stage. This was due, in part, to leaf loss prior to the third harvest and severe bird damage in some plots. The DM yield for the forage sorghum tended to decrease and grain yield increase as maturity advanced. Grain-to-forage ratios increased with advancing maturity for both sorghum types. However, this increase was significant only for the grain sorghums.

The effect of harvest stage on silage composition is shown in Table 40.3. For the grain sorghums, pre-ensiling and silage DM contents were significantly higher with each advancing stage of maturity. Crude protein (CP) was highest

(10.5%) at the early-dough stage (P<.05). None of the grain sorghum hybrids dropped below 9.0% CP at any stage of maturity. Acid detergent fiber decreased with advancing maturity; however, only the difference between the early-dough and hard-grain stages was significant. Cellulose also decreased with advancing maturity, with the early-dough silage containing significantly more cellulose than silages made at the other two stages. For the forage sorghum, silage DM content followed a pattern similar to the pre-ensiled forage, with the early-dough silage having less (P<.05) DM than silages made at the two later stages.

The effect of harvest stage on silage fermentation characteristics is shown in Table 40.4. Silages made at all three stages were well preserved and lactic acid was predominant. For the grain sorghum silages, lactic, acetic, and total fermentation acids decreased and pH values increased (P<.05) as maturity advanced. The lactic to acetic ratio decreased (P<.05) from the early-dough to the hard-grain stage. Ammonia-nitrogen was highest (P<.05) in the early-dough stage silages. For the forage sorghum silage, lactic acid was significantly higher in the early-dough stage silage than in the late-dough or hard-grain silages. The late-dough stage silage had the highest pH value (P<.05). The lactic to acetic ratio decreased (P<.05) with advancing maturity for the forage sorghum.

Trial 2. Differences in days to half bloom and plant height among the four grain sorghum hybrids were greater than among the five hybrids in Trial 1 (Table 40.5).

The results for harvest dates, compositions, and yields are also presented in Table 40.5. An average of 29 days elapsed between the first and third harvest dates. The initial harvest was made on September 7 for WAC 652G (late-milk to early-dough stage) and the last harvest made on October 24 for Asgrow Colt (hard-grain stage). Whole-crop DM content was significantly higher at each successive harvest stage for all four hybrids. Crude protein was highest (P<.05) at the first harvest stage for three of the four hybrids. Whole-crop DM yield was affected by stage of maturity only for WAC 652G, with the late-milk to early-dough stage having a lower yield (P<.05) than the hard-grain. Grain yield was lowest (P<.05) at the first harvest for all hybrids.

Table 40.1. Maturity and Plant Height for the Six Sorghum Hybrids in Trial 1

Hybrid	Sorghum Type	Days to Half Bloom	Plant Height, Inches
DeKalb DK-42Y	Grain	61.1^{a}	43^{ab}
Northrup-King 2778	Grain	61.3^{a}	43^{ab}
TX 2752 x TX 430	Grain	62.1^{b}	43^{ab}
Funk's G-522DR	Grain	63.1^{c}	42^{a}
Asgrow Colt	Grain	65.2^{d}	44^{b}
Pioneer 947	Forage	71.7^{e}	78^{c}

^{a,b,c,d,e}Means with different superscripts differ (P<.05).

Table 40.2. Effect of Harvest Stage on Yield of the Grain and Forage Sorghums in Trial 1

Sorghum Type and Item	Harvest Stage			
	Early-dough	Late-dough	Hard-grain	SE
Grain Sorghums[1]				
Whole-crop DM Yield, Tons/Acre	5.09^{b}	5.64^{a}	5.08^{b}	.18
Grain Yield, Bu/Acre[2]	68.2^{c}	101.9^{a}	93.8^{b}	.15
Grain:Forage	$.48^{b}$	$.79^{a}$	$.82^{a}$	.04
Forage Sorghum				
Whole-crop DM Yield, Tons/Acre	6.06	5.96	5.70	.53
Grain Yield, Bu/Acre[2]	83.4	85.5	91.2	.39
Grain:Forage	.50	.53	.62	.05

[1] Average of five hybrids.

[2] Adjusted to 12.5% moisture.

[a,b,c] Means in the same row with different superscripts differ ($P<.05$).

Table 40.3. Effect of Harvest Stage on Silage Composition of the Grain and Forage Sorgums in Trial 1

Sorghum Type and Item	Harvest Stage			
	Early-dough	Late-dough	Hard-grain	SE
Grain Sorghums[1]				
Dry matter:				
Pre-ensiled Crop, %	32.9^{a}	41.8^{b}	51.3^{c}	.01
Silage, %	32.2^{a}	40.0^{b}	50.5^{c}	.34
		% of the Silage DM		
Crude Protein	10.5^{a}	9.7^{b}	9.5^{b}	.10
Neutral Detergent Fiber	48.8	47.1	49.3	.57
Acid Detergent Fiber	27.8^{b}	26.2^{ab}	25.5^{a}	.40
Cellulose	20.5^{b}	18.8^{a}	18.0^{a}	.24
Lignin	4.4	4.5	4.6	.11
Forage Sorghum				
Dry matter:				
Pre-ensiled Crop, %	39.1^{a}	45.2^{b}	45.5^{b}	.01
Silage, %	37.4^{a}	43.6^{b}	44.8^{b}	1.06
		% of the Silage DM		
Crude Protein	8.2	8.1	7.9	.18
Neutral Detergent Fiber	55.5	52.1	54.1	1.07
Acid Detergent Fiber	31.9	31.1	32.6	.81
Cellulose	22.8	22.5	23.3	.87
Lignin	5.7	6.1	6.0	.21

[1] Average of five hybrids.

[a,b,c] Means in the same row with different superscripts differ ($P<.05$).

Table 40.4. Effect of Harvest Stage on Silage Fermentation Characteristics of the Grain and Forage Sorghums in Trial 1

Sorghum Type and Item	Harvest Stage: Early-dough	Late-dough	Hard-grain	SE
Grain Sorghums[1]	------- % of the Silage DM		--------	
Lactic Acid	5.72^{a}	3.97^{b}	2.92^{c}	.18
Acetic Acid	2.22^{a}	1.66^{ab}	1.32^{b}	.08
Butyric Acid	$.07^{a}$	$.23^{ab}$	$.59^{b}$	.12
Total Fermentation Acids	8.01^{a}	5.87^{b}	4.86^{b}	.19
pH	4.08^{a}	4.34^{b}	4.78^{c}	.03
Lactic:Acetic	2.72^{a}	2.44^{ab}	2.16^{b}	.14
Ammonia-nitrogen[2]	8.75^{a}	6.92^{b}	6.78^{b}	.09
Forage Sorghum	------- % of the Silage DM		--------	
Lactic Acid	5.06^{a}	3.00^{b}	3.22^{b}	.41
Acetic Acid	1.78	1.49	2.36	.36
Butyric Acid	.08	<.01	.02	.04
Total Fermentation Acids	6.93^{a}	4.50^{b}	5.61^{ab}	.60
pH	4.26^{a}	4.60^{b}	4.21^{a}	.03
Lactic:Acetic	2.84^{a}	2.01^{ab}	1.55^{b}	.25
Ammonia-nitrogen[2]	5.68	5.62	5.70	.004

[1] Average of five hybrids.

[2] Expressed as a % of the total nitrogen.

[a,b,c] Means in the same row with different superscripts differ (P<.05).

Table 40.5. Maturities, Plant Heights, Harvest Dates, Compositions, and Whole-crop Forage and Grain Yields for the Four Grain Sorghum Hybrids in Trial 2

Hybrid	Harvest Stage[1]	Harvest Date	Whole-crop[2] DM	Whole-crop[2] CP	Whole-crop DM Yield	Grain Yield[3]	Grain: Forage
			%	%	Tons/Acre	Bu/Acre	
WAC 652G	1	Sept. 7	29.0^{a}	11.6^{a}	4.4^{b}	64.6^{c}	$.59^{b}$
(63[4], 51[5])	2	Sept. 17	32.9^{b}	10.7^{b}	4.9^{ab}	88.1^{b}	$.82^{a}$
	3	Oct. 4	40.2^{c}	10.2^{b}	5.3^{a}	100.8^{a}	$.91^{a}$
DeKalb DK-42Y	1	Sept. 9	27.9^{a}	11.7^{a}	4.8	46.1^{c}	$.32^{b}$
(69, 47)	2	Sept. 19	31.0^{b}	10.6^{b}	5.1	78.5^{b}	$.63^{a}$
	3	Oct. 14	41.3^{c}	10.1^{b}	5.1	94.6^{a}	$.83^{a}$
NC+ 174	1	Sept. 16	28.2^{a}	10.4^{a}	5.1	83.8^{b}	$.70^{b}$
(71, 53)	2	Sept. 24	30.8^{b}	9.7^{b}	5.8	102.7^{a}	$.81^{b}$
	3	Oct. 15	41.2^{c}	9.2^{b}	5.2	111.6^{a}	1.20^{a}
Asgrow Colt	1	Sept. 24	26.9^{a}	10.0	5.4	85.4^{b}	.66
(78, 52)	2	Oct. 2	30.9^{b}	10.0	5.7	97.4^{a}	.75
	3	Oct. 24	42.2^{c}	9.4	5.1	86.9^{ab}	.74

[1] Harvest stage 1, late-milk to early-dough; stage 2, late-dough; and stage 3, hard-grain.

[2] 100% dry matter basis.

[3] Adjusted to 12.5% moisture basis.

[4] Days to half bloom.

[5] Plant height, inches.

[a,b,c] Means within a hybrid with different superscripts differ (P<.05).