EFFECTS OF HYBRID, GROWING CONDITION, STORAGE TIME, AND PIONEER 1174® SILAGE INOCULANT ON AGRONOMIC PERFORMANCE AND NUTRITIVE VALUE OF WHOLE-PLANT CORN AND GRAIN SORGHUM SILAGES[1]

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Summary

In 1989, two Pioneer corn hybrids, 3377 and 3389, were grown under irrigation and harvested at 80% milk line kernel maturity. Voluntary intakes and ADF digestibilities were similar for all hybrid, inoculant, and storage time combinations; however, DM digestibility was higher for 3377 silage than for 3389, and DM, CP, and NDF digestibilities were higher at the 50- than the 250-day storage time. The inoculant did not influence either voluntary intake or digestibility.

In 1990, the same corn hybrids and DeKalb DK 42Y and Pioneer 8358 grain sorghum hybrids were grown under both irrigated and dryland conditions. Whole-plant DM contents were similar for irrigated hybrids, but dryland corns had lower DM values than sorghums. Whole-plant DM yields were higher for irrigated hybrids, and irrigated corns had higher yields than irrigated grain sorghums. Grain yields were higher for dryland grain sorghums than for dryland corns. Significant crop × growing condition × storage time interactions occurred for voluntary intake, DM, NDF, and ADF digestibilities. At 50 days, voluntary intake was higher for grain sorghums, and whole-plant DM digestibilities were similar within each crop, but grain sorghum silages had lower digestibilities than corn silages. At 50 days, voluntary intake was similar for all silages, and DM digestibility was higher for irrigated corn silages than for dryland corn silages and for all grain sorghum silages.

The agronomic performances of the irrigated and dryland grain sorghums suggest that they are equivalent to dryland corn silage. Irrigated and dryland grain sorghum silages were of similar nutritive quality to the corn silages.

(Key Words: Corn, Sorghum, Silage, Hybrid, Inoculant.)

Introduction

Silage production in the United States is dominated by corn. Producers who grow their own corn or cattlemen who purchase corn for silage tend to select hybrids more for high grain-yield potential than for good silage traits. Previously, we found that irrigated silages, with a higher percentage of grain, were not more digestible than dryland silages (KAES Report of Progress 592, page 110). Irrigated and dryland grain sorghums had higher silage and grain yields than to dryland corn.

There is a long standing belief that, once ensiled material reaches the stable phase, all biological processes cease. However, there are few if any research data to confirm that belief.

Our objectives were: 1) to continue evaluating corn and grain sorghum hybrids for

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silage agronomic performance and 2) to evaluate the effects of irrigated and dryland growing conditions, storage time, and Pioneer 1174® inoculant on the nutritive value of corn and sorghum silages.

Experimental Procedures

Experiment 1: 1989. Two mid-maturing Pioneer corn hybrids, 3377 and 3389, were grown under irrigation in 1989 on a Reading silt loam soil near the Kansas State University campus. Both hybrids were planted on May 4. Prior to planting, anhydrous ammonia was applied at 100 lb per acre. Soil tests indicated that phosphorus and potassium were adequate. Furadan 15G insecticide was applied in the furrows at planting, followed the next day by Ramrod-atrazine preemergence herbicide. The experiment was arranged in a completely randomized design. Each plot had six, 400 ft long rows, 30 in. apart. Both hybrids were harvested when the kernels at the center of the ear reached approximately 80% milk line stage of maturity.

Agronomic data collected for each hybrid included plant density, plant height, plant part proportions, grain yield, and whole-plant dry matter (DM) content and yield. Whole-plant DM yields were determined by harvesting six rows with a FieldQueen forage harvester. The fresh material was weighed, mixed, sampled, then divided in half and treated with distilled water (control) or Pioneer 1174® silage inoculant at the recommended rate. The material was ensiled in 55 gal., plastic-lined, metal drum, pilot silos. They were filled, compacted, weighed, sealed, randomly assigned to 50- or 250-day storage times, and stored outside at ambient temperature until emptied and fed.

Twenty eight, mature, crossbred wethers were blocked by weight and randomly assigned (seven per silage) to the four silages for voluntary intake and digestion trials. Each trial consisted of 10-day silage adaptation, 7-day voluntary intake, 2-day adjustment to 90% of voluntary intake, and 6-day total fecal collection phases. Rations were 90% silage and 10% supplement (DM basis), formulated to 11.5% crude protein. The wethers averaged 101 lb at the start of the 50-day storage trial and 107 lb for the 250-day storage trial.

Experiment 2: 1990. Pioneer 3377 and 3389 corn hybrids and two mid-maturing grain sorghum hybrids, Pioneer 8358 and DeKalb DK 42Y, were planted under both irrigated and dryland conditions in 1990, using the same field and culture practices as in Experiment 1. The corn and grain sorghum hybrids were planted on May 2 and May 23, respectively. The experiment was a 2 × 2 × 2 × 2 factorial; two growing conditions (irrigated and dryland), two corn hybrids, two sorghum hybrids, and two storage times (50 and 250 days), in a split-plot design. Hybrids were randomly assigned to a plot within each growing condition for each of three replications. Each plot had six, 125 ft long rows, 30 in. apart. Corns were harvested when the middle kernels of the ear reached 80% milk line; sorghums when the middle kernels of the head reached late-dough.

The chopped material from the three replicates of each crop was composited; mixed; treated with Pioneer 1174® silage inoculant at the recommended rate; and ensiled in 55 gal., plastic-lined, metal drum pilot silos.

Forty mature, crossbred wethers were blocked by weight and randomly assigned to the eight silages for voluntary intake and digestion trials. The wethers averaged 99 lb at the start of the 50-day trial and 110 lb for the 250-day storage trial. All other procedures were as in Experiment 1.

Results and Discussion

Agronomic performance and plant part proportions for the 10 silage crops in the two experiments are presented in Table 1. In 1989, Pioneer 3377 had a higher proportion of grain than Pioneer 3389; however, in 1990, the two hybrids were similar within each growing condition. In 1990, whole-plant DM yields were higher for the four irrigated hybrids than their dryland counterparts, and the irrigated corns had higher total silage yields than irrigated grain sorghums. Grain

yields were higher for the dryland grain sorghums than for dryland corns.

Dry matter content and chemical composition for the 50- and 250-day silages in Experiments 1 (1989) and 2 (1990) are shown in Tables 2 and 3, respectively. In both years, DM and ADF contents generally increased with storage time, indicating water loss and metabolism of soluble components during storage. In Experiment 2, CP content was much more variable for the corn than for the sorghum silages, ranging from 9.1 to 12.5% and 9.6 to 11.4%, respectively. At both 50 and 250 days, the two dryland corn silages had higher CP and ADF values than the two irrigated corn silages.

Nutritive values of the silages in Experiments 1 and 2 are presented in Tables 4 and 5, respectively. In Experiment 1, voluntary intakes (VI) and ADF digestibilities were similar for all hybrid, inoculant, and storage time combinations; however, DM digestibility was higher for 3377 silage than 3389, and DM, CP, and NDF digestibilities were higher at the 50- than 250-day storage time. The Pioneer 1174 inoculant did not influence either VI or digestibilities for any hybrid or storage time combination.

In Experiment 2 (Table 5), significant crop by growing condition by storage time interactions occurred for VI and DM, NDF, and ADF digestibilities. At 50 days, intakes were higher for sorghum than for corn silage. The difference had disappeared by 250 days. At 50 days, digestibility was higher for corn than sorghum silage, with no difference due to irrigation. By 250 days, irrigated corn silage was more digestible than dryland, but there was no irrigation effect for sorghum silage.

The agronomic performance (Table 1; 1990 data) of both crops was significantly affected by growing condition, and the two corn hybrids were affected much more than the two sorghum. These data also suggest that under dryland conditions, grain sorghum is equivalent to corn for silage production. Furthermore, irrigated and dryland grain sorghum silages were of similar nutritional quality to the corn silages.

Table 1. Harvest Date; Plant Density; Plant Height; Dry Matter (DM) Content; Whole-plant DM, Grain, and Stover Yields; and Plant Part Proportions of the Corn and Grain Sorghum Hybrids in Experiments 1 (1989) and 2 (1990)

	Harvest	Plants/	Plant height,	Whole-plant DM and DM yield,		Grain yield,	Plant part proportions, %		
Hybrid	date	acre	inches	%	T/A[1]	bu/A[2]	grain	stover	head or cob
Corn				))))))))))))) 1989: irrigated)))))))))))))					
3377	Aug. 30	17,000	102	30.0	5.0	115.7	44.4	45.1	10.5
3389	Aug. 24	18,900	102	27.6	5.5	108.1	36.3	51.8	11.9
Corn				))))))))))))) 1990: irrigated)))))))))))))					
3377	Aug. 22	20,500	94	32.8	6.1	126.7	44.8	45.9	9.3
3389	Aug. 19	19,500	90	30.9	6.5	115.7	44.1	47.0	8.9
Sorghum									
DK42Y	Aug. 30	43,000	56	32.5	4.4	65.3	42.6	42.9	14.5
8358	Aug. 28	43,600	60	32.9	5.0	98.8	47.6	38.6	13.8
Corn				))))))))))))) 1990: dryland)))))))))))))					
3377	Aug. 23	20,350	90	29.0	4.3	18.6	28.4	60.9	10.7
3389	Aug. 22	19,600	88	29.5	4.1	22.4	25.8	63.3	10.9
Sorghum									
DK42Y	Sept. 1	42,400	49	38.1	4.0	60.0	39.5	47.1	13.4
8358	Sept. 3	42,300	47	33.6	4.0	78.3	43.9	43.4	12.9

[1]Tons per acre. [2]Bushels per acre; adjusted to 14.5% moisture.

Table 2. Dry Matter Content and Chemical Composition for the 50- and 250-Day Corn Silages in Experiment 1 (1989)

Hybrid and inoculant treatment	DM[1] %	CP	NDF	ADF
		))))) % of the silage DM)))))		
3377		)))))))))) 50 day silage))))))))))		
Control	30.6	9.8	62.7	21.1
1174	30.0	9.8	60.0	21.3
3389				
Control	28.0	9.0	59.0	26.5
1174	28.0	9.4	62.4	23.3
3377		)))))))))) 250 day silage))))))))))		
Control	33.5	8.6	55.8	22.1
1174	34.9	8.9	52.2	21.5
3389				
Control	31.5	8.3	62.3	28.8
1174	32.3	8.5	63.5	26.7

[1]DM = dry matter; CP = crude protein; NDF = neutral detergent fiber; and ADF = acid detergent fiber.

Table 3. Dry Matter Content and Chemical Composition for the 50- and 250-Day Corn

Hybrid and growing condition[1]	DM[2] %	CP	NDF	ADF
		)))) % of the silage DM))))		
Corn		))))))))) 50 day silage))))))))))		
3377 I	28.9	10.8	70.8	28.7
3377 D	24.2	12.5	65.5	30.5
3389 I	30.0	9.1	67.7	29.1
3389 D	25.2	12.3	64.0	31.8
Sorghum				
DK 42Y I	30.8	11.1	65.2	32.1
DK 42Y D	37.1	11.0	64.4	28.5
8358 I	32.2	9.6	59.6	26.3
8358 D	32.6	10.8	55.2	27.2
Corn		)))))))))) 250 day silage))))))))))		
3377 I	31.8	10.1	63.7	29.7
3377 D	25.0	12.2	62.3	31.3
3389 I	33.1	9.2	60.1	27.5
3389 D	27.5	12.4	63.3	33.8
Sorghum				
DK 42Y I	31.7	11.4	61.3	34.5
DK 42Y D	37.5	11.4	61.2	26.1
8358 I	33.4	10.4	57.6	33.6
8358 D	34.6	11.2	55.8	30.0

[1]I = irrigated and D = dryland. [2]DM = dry matter; CP = crude protein; NDF = neutral detergent fiber; and ADF = acid detergent fiber.

Table 4. Main Effects of Corn Hybrid, 1174 Inoculant, and Storage Time on Voluntary Intake and Nutrient Digestibilities for the Silage Rations in Experiment 1 (1989)

		Digestibility, %			
Main effect	VI[1]	DM	CP	NDF	ADF
Hybrid					
3377	81.4	71.7[a]	68.8	62.8	43.4
3389	83.0	69.3[b]	68.2	62.6	47.7
Inoculant					
Control	81.0	70.6	67.9	63.1	47.2
1174	83.4	70.4	69.1	62.2	43.8
Storage time					
50 days	81.5	71.7[a]	69.6[a]	65.3[a]	45.7
250 days	82.9	69.3[b]	67.4[b]	60.0[b]	44.8

[1]VI = voluntary intake as g of DM per kg body $wt^{.75}$; DM = dry matter; CP = crude protein; NDF = neutral detergent fiber; and ADF = acid detergent fiber.
[ab]Means in the same column within main effects with different superscripts differ significantly ($P < .05$).

Table 5. Effects of Crop, Hybrid, and Growing Condition on Voluntary Intake and Nutrient Digestibilities for the 50- and 250-Day Silage Rations in Experiment 2 (1990)

Hybrid and		Digestibility, %			
growing condition[1]	VI[2]	DM	CP	NDF	ADF
Corn		))))))))) 50 day silage))))))))))			
3377 I	85.1[b]	63.6[a]	68.5[abc]	59.5[ab]	42.1[bc]
3377 D	82.8[b]	65.1[a]	70.4[ab]	60.7[ab]	52.4[a]
3389 I	88.3[ab]	65.1[a]	67.2[abc]	61.9[a]	49.2[ab]
3389 D	81.1[b]	62.7[a]	71.8[a]	56.5[bc]	49.4[ab]
Sorghum					
DK 42Y I	89.5[a]	59.7[b]	69.6[ab]	53.6[cde]	45.7[abc]
DK 42Y D	97.8[a]	60.4[b]	65.2[bc]	56.0[bcd]	46.3[abc]
8358 I	92.0[a]	60.2[b]	63.8[c]	50.8[de]	31.8[d]
8358 D	96.6[a]	61.4[b]	65.4[bc]	48.8[e]	41.4[c]
Corn		))))))))) 250 day silage))))))))))			
3377 I	93.5	66.0[a]	67.9[abc]	54.8[ab]	46.5[a]
3377 D	88.5	60.2[b]	70.8[ab]	48.1[cd]	41.3[ab]
3389 I	88.8	67.2[a]	66.1[bc]	55.9[a]	46.8[a]
3389 D	93.2	61.1[b]	69.0[abc]	49.2[bcd]	44.2[a]
Sorghum					
DK 42Y I	89.0	60.9[b]	72.4[a]	49.3[bcd]	47.5[a]
DK 42Y D	96.8	62.4[b]	69.9[abc]	50.7[abc]	35.3[b]
8358 I	93.1	60.2[b]	66.1[bc]	45.7[cd]	45.4[a]
8358 D	97.5	59.9[b]	64.8[c]	43.9[d]	42.7[ab]
Crop × Cond. × Time (P level)[3]	.004	.001	NS	.001	.003

[1]I = irrigated and D = dryland.
[2]VI = voluntary intake as g of DM per kg body $wt^{.75}$; DM = dry matter; CP = crude protein; NDF = neutral detergent fiber; and ADF = acid detergent fiber.
[3]Crop by growing condition by storage time interaction and level of significance.
[abcde]Means in the same column and within storage time with different superscripts differ significantly ($P < .05$).