Kansas Agricultural Experiment Station Research Reports

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

Article 629

1995

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Abstract

Corn and forage sorghum silages were stored in small bunker silos for 180 days. Dry matter (DM) and organic matter (OM) losses, fermentation characteristics , in-situ DM digestibility, and temperatures were measured at 10, 20, and 30 inches from the original silage surface. Sealing the exposed surface increased DM and OM recoveries and improved fermentation quality and nutritive value in both crops, regardless of depth. The unsealed corn silages were much hotter within the top 3 ft than sealed silages, indicating aerobic losses. As expected , the unsealed silages from both crops deteriorated severely i n the top 20 inches. Placing a roof over the unsealed silos increased the silage DM content at all three depths, but did not consistently improve the storage efficiency or silage quality of either crop.

Keywords

Cattlemen's Day, 1995; Kansas Agricultural Experiment Station contribution; no. 95-357-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 727; Beef; Silage; Top spoilage; Corn; Sorghum

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TOP SPOILAGE LOSSES FOR CORN AND FORAGE SORGHUM SILAGES STORED IN BUNKER SILOS [1]

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Summary

Corn and forage sorghum silages were stored in small bunker silos for 180 days. Dry matter (DM) and organic matter (OM) losses, fermentation characteristics, *in-situ* DM digestibility, and temperatures were measured at 10, 20, and 30 inches from the original silage surface. Sealing the exposed surface increased DM and OM recoveries and improved fermentation quality and nutritive value in both crops, regardless of depth. The unsealed corn silages were much hotter within the top 3 ft than sealed silages, indicating aerobic losses. As expected, the unsealed silages from both crops deteriorated severely in the top 20 inches. Placing a roof over the unsealed silos increased the silage DM content at all three depths, but did not consistently improve the storage efficiency or silage quality of either crop.

(Key Words: Silage, Top Spoilage, Corn, Sorghum.)

Introduction

Large horizontal silos (i.e., bunkers, trenches, and stacks) store large quantities of ensiled feeds economically, but by design, much of the silage is exposed to the environment. In 1,000 ton silos (100 ft long × 40 ft wide × 12 ft deep), up to 25% of the original silage mass is within 3 feet of the surface. In earlier studies, we found that DM losses in unsealed bunkers were 80.4 and 29.4% at depths of 10 and 20 inches, respectively, for corn silage after 6 months of storage and 77.0 and 53.2% for forage sorghum silage at the same depths (KAES Report of Progress 651, page 131). However, sealing with polyethylene sheeting significantly reduced the DM losses for both crops at both depths. Our objectives were: 1) to measure the rate and extent of top spoilage losses in unsealed and sealed silages and 2) to determine the effect of placing a roof over the silage mass on preservation efficiency and nutritive value. To our knowledge, the feasibility of using a roof to protect unsealed corn or sorghum silage from rain and snowfall has not been studied in controlled experiments.

Experimental Procedures

Experiment 1: Whole-Plant Corn. On August 25 and 26, 1992, whole-plant corn (2/3 milk line maturity and 34.2% DM) was chopped and packed into four, 16 ft long × 13.5 ft wide × 4 ft deep, bunker silos. Alternate loads were used to fill the bottom half of each silo on the first day and the top half of each silo on the second day. During filling, nylon net bags, each containing 4.5 lb of fresh material, were placed 10, 20, and 30 inches from the surface of the original ensiled mass (three bags/depth/silo). Thermocouples were placed at each bag location, and temperatures were recorded for the first 42 days. The silos contained similar amounts of fresh material and were packed with single-tired tractors to equal densities (13.8 lb of DM/cubic ft). Treatments were: 1) silo left

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unsealed, no roof; 2) sealed, no roof; 3) left unsealed, with a roof; and 4) sealed, with a roof. Both sealed silos were covered with a single sheet of .4 mm polyethylene, weighted with tires. A galvanized tin roof was used for treatments 3 and 4. Bunkers were emptied 180 days postfilling. The nylon net bags were recovered, and the silage was weighed; mixed; sampled; and analyzed for DM, ash, pH, and fermentation end products.

Experiment 2: Forage Sorghum. On October 20 and 21, 1992, whole-plant, Northrup King 300, forage sorghum (late-dough maturity and 37.1% DM) was chopped and packed to equal densities (10.2 lb of DM/cubic ft) into four bunker silos. All experimental procedures were the same as in Experiment 1.

***In-Situ* Digestibility**. Ruminal DM disappearance was determined for the silages from the nylon net bags recovered from the bunker silos in Experiments 1 and 2. Three ruminally cannulated steers were used. Approximately 1 g of dried, ground silage was placed in a 5 cm × 10 cm dacron bag with a 53 micrometer pore size. Silages were digested for 72 hours. Once removed from the rumen, the bags were rinsed with cold water until the water was clear. Bags and undigested material were dried in a forced-air oven at 55°C for 72 h and then weighed; DM disappearance was calculated.

Results and Discussion

Experiment 1: Whole-Plant Corn. Results are presented in Table 1. The two silages from the unsealed silos had dramatically lower DM and OM recoveries at the 10- and 20-inch depths than the two sealed silos. Sealed silages were well preserved at all three depths, but in the unsealed silos, only the silage at the 30-inch depth was acceptable. The silage in the unsealed, roofed silo had the highest DM content at all depths, whereas the unsealed, no-roof silage had the lowest. Temperatures in the two sealed silos and the unsealed, no-roof silo peaked within the first 4 to 12 days postfilling, but temperatures in the unsealed, roofed silo did not reach maximum until 40 to 44 days. Few fermentation differences were observed among the sealed silages. The poor fermentation at the 10-inch depth in the sealed, roofed silage was caused by rodent damage to the polyethylene. The two unsealed silages were of dramatically lower quality, as indicated by increased pH values, lower lactic acid content, and decreased lactic:acetic ratios (data not shown), especially at the 10- and 20-inch depths. Silages were of acceptable quality at the 30-inch depth in both unsealed silos. The silages in the two sealed silos and the unsealed, roofed silo had higher ruminal *in-situ* DM digestibilities at all three depths than the silage in the unsealed, no-roof silo. In both unsealed silos, silage at the 10-inch depth had a lower *in-situ* DM digestibility than silages at the 20- and 30-inch depths, indicating that much of the digestible organic matter had been removed by weathering and(or) spoilage.

Experiment 2: Forage Sorghum. Results are presented in Table 2. The unsealed, no-roof silage had the lowest DM content at all three depths, whereas the unsealed, roofed silage had the highest. Unsealed silages had dramatically lower DM and OM recoveries at the 10-inch depth than the two sealed silages. The unsealed, roofed silage had the lowest recoveries at the 20-inch depth. The two unsealed silages had deteriorated severely at the 10-inch depth, as evidenced by high pH values and almost no fermentation end products. The silages at all three depths in the two sealed silos and the unsealed, roofed silo had higher ruminal *in-situ* DM digestibilities than that in the unsealed, no-roof silo.

Conclusions. During the 180 days of storage, water from rain and snow percolated through the unsealed, no-roof silage for both crops, and the silages at all three depths were much wetter than the pre-ensiled forages. In contrast, the silages at the 10- and 20-inch depths in the unsealed, roofed silos were much drier than the pre-ensiled forages, because considerable dehydration/evaporation took place in the absence of a seal.

These data document that sealing corn or forage sorghum silages in bunker, trench, or stack silos greatly increases preservation efficiency and nutritive value in the original top 2 to 3 ft of ensiled material.

Table 1. Effects of Sealing Treatment and Depth from the Original Surface on the DM Content, DM and OM Recoveries (rec.), Temperature (temp.), Fermentation Characteristics, and DM Digestibility (DMD) of Corn Silages Stored in Bunker Silos in Experiment 1

Sealing Treatment	Depth	DM	DM Rec.[1]	OM Rec.[2]	Maximum Temp.[3]	In-Situ DMD	pH	Lactic Acid	Acetic Acid	Ethanol
	inches	%			°F	%		- % of the silage DM -		
Unsealed,	10	15.6	24.9	24.4	113(10)	37.1^{d,y}	7.11	.07	.13	.08
no roof	20	23.2	75.0	76.9	105(12)	63.1^{b,x}	3.84	.97	3.21	.41
	30	24.4	76.7	77.6	97 (4)	65.7^{b,x}	3.86	5.21	4.22	1.43
no roof	20	33.6	92.4	92.7	95 (6)	71.2^{a}	3.79	4.23	1.48	1.40
	30	32.8	93.6	93.3	95 (4)	71.9^{a}	3.88	4.31	1.60	1.67
roof	20	37.3	82.8	83.2	127(40)	70.4^{a,x}	5.11	.89	.96	.15
	30	34.9	93.8	93.7	114(44)	72.7^{a,x}	4.01	4.55	1.42	.58
roof	20	35.1	94.5	94.5	96 (8)	68.6^{a}	3.85	4.48	1.71	1.06
	30	33.1	94.1	93.0	96 (4)	71.7^{a}	3.87	4.61	1.63	1.59

[1]Expressed as a % of the original DM ensiled. [2]Expressed as a % of the original OM ensiled. [3]The day postfilling when the maximum temperature occurred is shown in parentheses. [4]ND=not detected. [a,b,c,d]Means within a depth across sealing treatment with different superscripts differ (P<.05). [x,y]Means within a sealing treatment across depth with different superscripts differ (P<.05).

Table 2. Effects of Sealing Treatment and Depth from the Original Surface on the DM Content, DM and DM Recoveries (rec.), Fermentation Characteristics, and DM Digestibility (DMD) of the Forage Sorghum Silages Stored in the Bunker Silos in Experiment 2

Sealing Treatment	Depth	DM	DM Rec.[1]	OM Rec.[2]	In-Situ DMD	pH	Lactic Acid	Acetic Acid	NH_3-N
	inches	%			%		- % of the silage DM -		
Unsealed,	10	14.0	52.3	52.5	35.8^{c,y}	6.68	ND[3]	.13	.04
no roof	20	26.1	95.0	95.1	57.7^{b,x}	5.08	3.37	2.45	.14
	30	25.6	91.5	91.5	55.1^{b,x}	4.94	3.13	2.27	.13
no roof	20	37.6	97.8	97.6	60.8^{a}	4.59	4.08	3.48	.13
	30	36.5	97.6	97.7	58.9^{b}	4.38	5.63	2.39	.10
roof	20	66.2	73.2	71.8	62.2^{a,x}	7.73	.08	.08	.12
	30	38.8	96.1	97.7	62.9^{a,x}	4.06	2.18	1.13	.12
roof	20	36.5	97.9	98.2	61.5^{a,x}	4.63	4.99	2.74	.16
	30	36.0	94.5	93.9	58.4^{b,x,y}	4.47	6.23	4.45	.17

[1]Expressed as a % of the original DM ensiled. [2]Expressed as a % of the original OM ensiled. [3]ND=not detected. [a,b,c]Means within a depth across sealing treatment with different superscripts differ (P<.05). [x,y]Means within a sealing treatment across depth with different superscripts differ (P<.05).