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D.L. Holthaus

D.R. Bonilla

L. Pfaff

See next page for additional authors

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Rate and extent of losses from top spoilage in alfalfa silages stored in bunker silos

Abstract

Alfalfa silages were made in pilot- and farm-scale silos, and five sealing treatments were compared. After 90 days, sealing dramatically reduced DM losses at the 5 and 10 in. depths in the farm silos and at the 0 to 12, 12 to 24, and 24 to 36 in. depths in the pilot silos. Extending the storage period to 180 days in pilot silos had no effect on DM losses for sealed or delay sealed silages, but DM losses for unsealed silages continued to increase at all three depths. Placing a roof over the unsealed, farm-scale silo increased the silage DM content at all three depths, increased storage temperatures at the 10 and 20 in. depths, and reduced DM loss at the 10 in. depth compared to the unsealed silo without a roof. Rainfall was much above normal (16.8 in. during the first 90 days of storage; 11.2 in. the second 90 days) and contributed to huge increases in the moisture content of silage at the lower depths in the unsealed, no roof, pilot- and farm-scale silos.

Keywords

Cattlemen's Day, 1993; Kansas Agricultural Experiment Station contribution; no. 93-318-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 678; Beef; Silage; Alfalfa; Top spoilage; Bunker silos

Authors

D.L. Holthaus, D.R. Bonilla, L. Pfaff, D. Haverkamp, B.S. Dalke, R.N. Sonon, K. Budiongo, K.K. Bolsen, and Matthew A. Young

RATE AND EXTENT OF LOSSES FROM TOP SPOILAGE IN ALFALFA SILAGES STORED IN BUNKER SILOS[1]

D. L. Holthaus, M. A. Young, D. R. Bonilla, L. Pfaff, D. Haverkamp, B. S. Dalke, R. N. Sonon, K. Budiongo, and K. K. Bolsen

Summary

Alfalfa silages were made in pilot- and farm-scale silos, and five sealing treatments were compared. After 90 days, sealing dramatically reduced DM losses at the 5 and 10 in. depths in the farm silos and at the 0 to 12, 12 to 24, and 24 to 36 in. depths in the pilot silos. Extending the storage period to 180 days in pilot silos had no effect on DM losses for sealed or delay sealed silages, but DM losses for unsealed silages continued to increase at all three depths. Placing a roof over the unsealed, farm-scale silo increased the silage DM content at all three depths, increased storage temperatures at the 10 and 20 in. depths, and reduced DM loss at the 10 in. depth compared to the unsealed silo without a roof. Rainfall was much above normal (16.8 in. during the first 90 days of storage; 11.2 in. the second 90 days) and contributed to huge increases in the moisture content of silage at the lower depths in the unsealed, no roof, pilot- and farm-scale silos.

(Key Words: Silage, Alfalfa, Top Spoilage, Bunker Silos.)

Introduction

Large horizontal silos (i.e., bunkers, trenches, and stacks) are economical for storing large quantities of ensiled feeds, but by design, much of the silage is exposed to the environment. In a silo with about 1,000 tons capacity (100 ft long × 40 ft wide × 12 ft deep), up to 25% of the original silage mass is within the top 3 feet. In an earlier study with alfalfa, we found that DM losses in an unsealed bunker exceeded 72 and 32% in the top 0 to 12 and 12 to 24 inches, respectively, after 12 wks of storage (KAES Report of Progress 623, page 74). However, sealing with polyethylene sheeting reduced the DM losses to less than 8% at each depth.

Our objectives were: 1) to continue measuring the rate and extent of top spoilage losses in unsealed and sealed alfalfa silages and 2) to determine the effects of delaying sealing and of placing a roof over the silage mass on preservation efficiency. To our knowledge, the feasibility of using a roof to protect an unsealed silage mass from rain and snowfall has not been studied in controlled experiments.

Experimental Procedures

Farm-scale silos. On June 25 and 26, 1992, second cutting alfalfa 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. All alfalfa was cut with a mower-conditioner and allowed to wilt for 24 h before chopping. While the silos were being filled, nylon net bags, each containing 4.4 lb of fresh material, were placed at depths of 5, 10, and 20 in. from the surface of the initial ensiled mass (3 bags/depth/silo). Thermocouples were placed at each bag location, and temperatures were recorded daily for the first 30 days, then twice weekly thereafter. The silos contained

[1]Financial assistance was provided by Kemin Industries Inc., Des Moines, Iowa and Mr. Richard Porter, Porter Farms, Reading, Kansas.

similar amounts of fresh material and were packed with tractors to densities that were similar to farm-scale conditions.

Treatments were: 1) left unsealed, without a roof; 2) sealed, without a 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 (Figure 1). Bunkers were emptied at 90 days postfilling. The nylon net bags were recovered after the settling depths had been recorded, and the silage was weighed, mixed, sampled, and analyzed for DM and pH.

Pilot-scale silos. The same chopped alfalfa that was used to fill the farm-scale silos was packed to equal densities into 33, polyethylene-lined, 55-gal drum, pilot-scale silos. Each drum was divided horizontally into thirds with nylon netting to partition the fresh material at 12 and 24 in. below the initial surface. A perforated 1.0 in. PVC pipe was placed at the bottom of the drums and connected through an air lock to drain percolated water. The first four treatments were the same as those described for the farm-scale silos, plus a fifth treatment in which sealing was delayed 7 days. All sealed silos were covered with a single .4 mm sheet of polyethylene; silos designated as not roofed were stored outside; silos designated as roofed were stored in an open-sided, metal building.

The "unroofed" pilot-scale silos were opened at 7, 90, and 180 days postfilling; the "roofed" silos were opened at 90 and 180 days; and delayed-seal silos were opened at 180 days. There were three silos per treatment at each opening time; the silage at each depth was weighed, mixed, and sampled; and the samples were analyzed for DM and pH. The distance that each nylon net partition had settled from the initial surface in each silo was also recorded.

Results and Discussion

The effects of sealing treatment, depth from the initial surface, and days postfilling on the preservation efficiency traits measured are shown in Table 1 and Figure 2 (farm-scale silos) and Table 2 (pilot-scale silos).

In the farm-scale silos, sealing (with or without a roof) dramatically reduced silage DM losses and storage temperatures at the 5 and 10 in. depths. The silages in the two sealed silos were well preserved at all three depths, but only the silage at the 20 in. depth in the two unsealed silos was of acceptable quality. Silage DM losses at the 20 in. depth ranged from 6.3 to 12.8% in the four silos. Temperatures in the two sealed silos peaked within the first 3 days postfilling; temperatures in the unsealed, no-roof silo peaked within the first 3 to 4 wks; but temperatures in the unsealed, roof silo remained high for the longest time, particularly at the 20 in. depth. The unusually high rainfall during the 90-day storage (16.8 in.) produced a large amount of percolated water through the unsealed, no-roof silage; and the silages at the 10 and 20 in. depths were 10.1 and 15.3 percentage units wetter than the pre-ensiled forage. In contrast, the silages at the 10 and 20 in. depths in the unsealed, roof silo were actually 22.3 and 2.3 percentage units drier than the pre-ensiled forage, as considerable dehydration/evaporation took place in the absence of a seal. Placing a roof over the unsealed silage did not affect DM losses at the 5 and 20 in. depths, but it did reduce DM loss from 52.4 to 23.4% at the 10 in. depth.

In the pilot-scale silos, sealing (with or without a roof) produced similar preservation traits (i.e., DM content, DM recovery, and pH) as the farm-scale silos after 90 days of storage; and there was little, if any, additional deterioration after 180 days. In general, the pilot-scale, unsealed, roof silos had similar silage preservation traits to the farm-scale silo; however, silages in the pilot-scale, unsealed, no-roof silos at 90 days were much more

deteriorated than their farm-scale counterpart. This is explained, in part, by a greater influence of the side-wall in the 2.1 ft diameter pilot silos vs. the 13.5 ft wide farm silos. Delayed sealing (7 days) resulted in a dramatic improvement in preservation efficiency in the top 36 in. of silage compared to no seal, which is consistent with our previous studies with corn and forage sorghum silages (KAES Report of Progress 651, page 135).

These data document that sealing alfalfa silage in bunker silos greatly increases preservation efficiency in the initial top 3 ft of ensiled material.

Table 1. Effects of Sealing Treatment and Depth from the Initial Surface on the Settling Distance, Dry Matter (DM) Content, DM Recovery (Rec.), pH, and Maximum Temperature (Temp.) of the Alfalfa Silages Stored in Farm-scale Bunker Silos

Sealing treatment	Initial depth, inches	Distance settled, inches[1]	Initial DM, %	90-day silage DM, %	90-day silage DM rec.[2]	90-day silage pH	Maximum temp.,[3]
Unsealed, no	5.0	3.0	55.3	65.4	66.4	8.21	148.3 (16)
roof	10.0	---	55.3	45.2	47.6	8.68	147.3 (17)
	20.0	4.6	50.8	35.5	90.6	4.85	125.9 (24)
Sealed, no	5.0	1.5	54.9	52.9	90.7	5.23	107.1 (1)
roof	10.0	---	54.9	52.7	91.1	5.28	110.0 (1)
	20.0	2.2	50.4	47.2	89.5	5.20	113.6 (1)
Unsealed,	5.0	< 1.0	53.4	72.0	64.2	8.10	142.5 (17)
roof	10.0	---	53.4	75.7	76.6	7.57	148.8 (35)
	20.0	< 1.0	47.2	49.5	87.2	4.63	134.7 (82)
Sealed,	5.0	< 1.0	56.8	57.8	91.5	5.41	111.0 (2)
roof	10.0	---	56.8	57.7	89.9	5.41	112.7 (3)
	20.0	1.4	50.3	53.8	93.7	5.20	108.9 (1)

[1]Depth settled during the 90-day storage period was not recorded at the 10-inch depth.
[2]Expressed as a % of the DM ensiled.
[3]The day postfilling when the maximum temperature occurred is shown in parentheses.

Table 2. Effects of Sealing Treatment, Depth from the Initial Surface, and Day Post-filling on Dry Matter (DM) Content, DM Recovery (Rec.), and pH of the Alfalfa Silages Stored on Pilot-scale Silos[1]

Sealing treatment	Initial depth, inches	Day post-filling	DM, %	DM, rec.[2]	pH
Unsealed, no roof	0 to 12	7	54.3	95.1	6.72
		90	27.1	37.8	7.71
		180	24.3	35.5	8.28
	12 to 24	7	52.2	95.7	5.53
		90	22.7	66.8	5.03
		180	21.3	59.3	5.74
	24 to 36	7	52.7	98.1	5.56
		90	23.5	77.9	4.90
		180	18.3	65.9	5.11
Sealed, no roof	0 to 12	7	52.4	95.4	5.50
		90	49.1	92.0	5.08
		180	46.8	93.2	5.01
	12 to 24	7	52.3	97.0	5.58
		90	52.1	93.6	5.26
		180	47.8	94.1	5.08
	24 to 36	7	52.6	97.3	5.62
		90	50.2	94.5	5.10
		180	48.9	93.2	5.07
Unsealed, roof	0 to 12	90	56.8	73.9	8.94
		180	47.9	57.4	8.96
	12 to 24	90	47.6	84.2	6.81
		180	45.1	80.8	6.63
	24 to 36	90	54.5	96.2	5.26
		180	49.9	90.4	5.10
Sealed, roof	0 to 12	180	50.4	92.5	5.06
	12 to 24	180	51.3	93.0	5.06
	24 to 36	180	50.9	91.5	5.02
Delay-sealed, no roof	0 to 12	90	49.4	87.3	5.33
		180	52.8	84.3	5.36
	12 to 24	90	51.4	93.4	5.16
		180	54.2	92.4	5.14
	24 to 36	90	49.9	94.7	5.12
		180	51.9	90.6	5.10

[1]Each value is the mean of three pilot-scale silos.
[2]Expressed as a % of the DM ensiled.

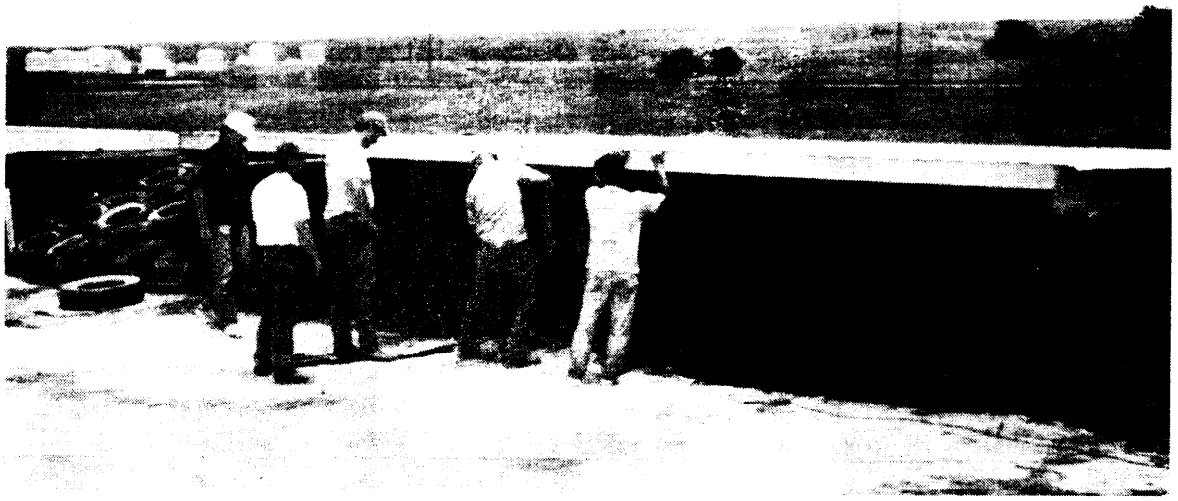

Figure 1. Attaching the Roofs to the Two Bunker Silos

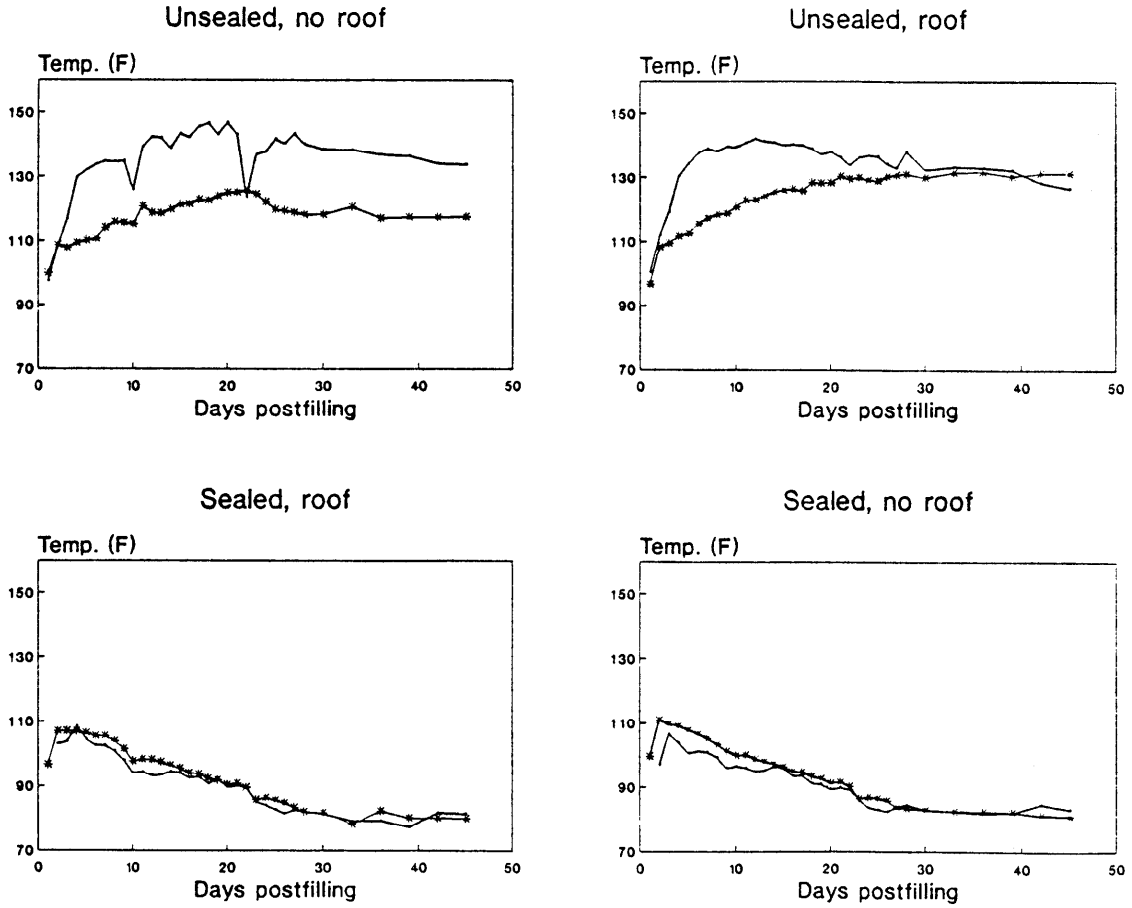

Figure 2. Effect of Sealing Treatment on the Temperature of the Alfalfa Silages during the First 6 Weeks of Storage in the Farm-scale Silos (depth below the initial surface: —□— = 5 inches and -+- 20 inches)