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Comparison of two different methods to harvest drought-damaged corn¹

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SUMMARY

Two methods of harvesting drought-stressed corn as large round bales were compared in this study. Three acres of drought-stressed corn were cut and either baled as high-moisture bales and wrapped in plastic (BALEAGE), or allowed to completely dry and baled with a conventional large round baler (DRY). Core samples were analyzed for moisture, CP, ADF, NDF and in vitro NDF and DM digestibility. Samples from the BALEAGE treatment were lower in CP than those from the DRY treatment. Concentrations of ADF and NDF did not differ between BALEAGE and DRY. Dry matter and NDF digestibility were also similar between the treatments. The challenges of physically handling the bales from the BALEAGE treatment and in maintaining the integrity of the plastic barrier limit the usefulness of this technique compared to either chopping the corn for silage or harvesting the corn as dry, large round bales.

INTRODUCTION

During drought conditions, it sometimes becomes necessary to salvage drought-stressed corn for forage rather than grain. The most common harvesting method and standard recommendation in these instances is to harvest the corn as silage. However, there can be obstacles and challenges to harvesting a failed corn crop as silage. The necessary equipment is not always available at the optimal time for harvesting silage, plus in some cases the distance from field to livestock feeding facility poses logistical challenges.

These challenges lead some producers to consider harvesting standing corn in large round bales. The major obstacle with this method is that the forage must cure in the field for an extended period of time (30 days or more) before the plant material is dry enough ($\leq 20\%$ moisture, ideally $< 15\%$) to safely be baled. This long drying period leads to a greater risk of deterioration because of weather exposure and limits opportunities to plant either cover crops or winter cereal grains to take advantage of any fall precipitation.

The purpose of this study was to examine if drought-stressed corn could be harvested at higher moisture content when processed as baleage. Baleage harvesting involves using a standard large round baler to harvest forage at high moisture content after a short wilting period rather than allowing the crop to completely dry down. The resulting bales are then wrapped in plastic to limit oxygen and promote anaerobic fermentation.

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MATERIALS AND METHODS

Three acres of drought injured corn plants at the Southeast Research Farm, Beresford, SD, were cut by a mower-conditioner on August 15, 2012. One half of the resulting windrows were baled on August 17 with a large round baler using net wrap. These bales were then wrapped in plastic (Figure 1). The remaining windrows were allowed to dry for 30 days and then baled with the same large round baler using only net wrap. Samples were taken from each individual BALEAGE bale on August 17 (INITIAL). Individual samples were taken from both the BALEAGE and DRY bales on October 15, 2012. Because the ends of the row of wrapped bales were exposed, the first and last bales from the BALEAGE treatment were excluded from the analysis.

Forage samples were sent to a commercial testing laboratory (Dairyland Laboratories, Inc., Arcadia, WI) for analysis. Samples were analyzed for moisture content, CP, ADF and NDF using NIR procedures and the same equations for all samples. In vitro digestibility for NDF and dry matter were also determined using a 48-hour incubation. Because the nitrate-nitrogen levels in the corn (20 to 185 ppm NO_3N , AgLab Express, Sioux Falls, SD, B. Rops, personal communication) were not high enough to warrant concern in feeding to cattle, nitrate concentrations were not analyzed in this experiment. Differences in composition between INITIAL, BALEAGE and DRY were determined by using the GLM procedure of SAS (PROC GLM, SAS Inst. Inc., Cary, NC) with bale representing the experimental unit.

RESULTS AND DISCUSSION

Sixteen BALEAGE bales and 8 DRY bales were harvested from 3.6 acres. Differences in bale numbers were attributed to shrinkage and wind loss during the 4-wk drying period, as well as less capture of plant material by the baler when dry compared to BALEAGE (B. Rops, personal communication). The results of the forage analyses are shown in Table 1. As expected the DRY samples contained the least moisture with the INITIAL samples having the highest moisture content with the BALEAGE intermediate ($P < 0.05$). The BALEAGE and DRY treatments were lower in pH compared to the INITIAL samples ($P < 0.05$). Crude protein content was also lower in the BALEAGE treatment compared to either INITIAL or DRY (6.4% compared to 8.6 and 8.0%, respectively, $P < 0.05$).

One explanation for the lower CP content observed in the BALEAGE treatment is that some of the nitrogen was carried by water movement into the lower portion of the bale. The moisture content when the BALEAGE bales were made is at the upper end of recommended moisture contents for silage harvesting. Seepage losses more commonly occur under higher moisture conditions. It's possible that if seepage occurred, the concentration of nitrogen-containing compounds might have been higher in the lower part of the bale where the hay probe did not reach. Another possible explanation for the observed differences in CP content could be that as protein was degraded by microbial action and/or fermentation, increased amounts of ammonia ($\text{NH}_3\text{-N}$) were produced (Kung and Der Bedrosian, 2010) that might not have been captured in the subsequent core sample.

The BALEAGE treatment was significantly less ($P < 0.05$) than the INITIAL treatment for both ADF (31.0 vs. 39.0%) and NDF (51.6 vs. 59.8%) concentrations, but not different than DRY. Both the BALEAGE and DRY treatments were higher in NDF digestibility (58.0 and 56.4%, respectively) compared to INITIAL treatment which was 51.1% ($P < 0.05$). The BALEAGE samples were also higher ($P < 0.05$) in IVDMD compared to INITIAL (78.3% compared to 70.6%) but not significantly different than the DRY treatment. The changes observed in the BALEAGE and DRY treatments are consistent with microbial activity and fermentation. The pH for samples taken in October was lower compared to samples taken immediately

at harvest, similar to what happens during the ensiling process. If microbial activity had degraded a portion of the cell wall constituents, changes in both fiber concentration and digestibility would be expected (Kung and Der Bedrosian, 2010).

Although results of this small experiment suggest that harvesting drought damaged corn as either baleage or dry large round bales is possible, they do not support changing the standard recommendation of chopping and ensiling as the preferred method to salvage a failed corn crop. The dry bales required 30 days drying time to reach what would be considered the maximum acceptable moisture content for safe baling. If moisture levels inside the bale were higher, extensive amounts of spoilage would be likely. Additionally, staff noted that a portion of the leaves and cobs were lost during the drying and baling process.

Whereas harvesting as baleage eliminates the extended waiting time and offers some degree of preservation, there are several practical challenges to this harvest method. First, if these bales are made to the same dimensions as a standard round bale, physically handling the bales is difficult because of the additional weight caused by higher moisture content (B. Rops, personal communication). Second, maintaining the integrity of the plastic is critical to avoid spoilage. As seen in Figure 2, spoilage occurred following core sampling in this study even when the holes had been patched with tape immediately after sampling. Based on these challenges, combined with the reduced CP levels seen in this study, the usefulness of this harvesting method as a way of salvaging drought-stressed corn is limited. Chopping and ensiling is still the best method of utilizing this feedstuff for ruminants.

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Table 1. NIR analysis and in vitro digestibility of corn hay samples

	INITIAL	BALEAGE	DRY	SEM	P Value
Moisture, %	68.2 ^a	63.1 ^b	16.2 ^c	0.85	<0.0001
DM, %	31.8 ^a	36.9 ^b	83.8 ^c	0.85	<0.0001
pH	5.26 ^a	4.35 ^b	4.44 ^b	0.1	<0.0001
CP, %	8.6 ^a	6.4 ^b	8.0 ^a	0.46	0.0035
ADF, %	39.0 ^a	31.0 ^b	36.0 ^{a,b}	2.25	0.027
NDF, %	59.8 ^a	51.6 ^b	57.4 ^{a,b}	2.48	0.036
NDFD ^d , %	51.1 ^a	58.0 ^b	56.4 ^b	1.73	0.011
IVDMD ^e , %	70.6 ^a	78.3 ^b	75.0 ^{a,b}	1.8	0.009

^{a,b,c} Means within a row having different superscripts are different ($P < 0.05$)

^d NDFD = Neutral detergent fiber digestibility

^e IVDMD = In vitro dry matter digestibility



Figure 1. Processing BALEAGE bales.
Picture courtesy of Brad Rops



Figure 2. Picture of BALEAGE after plastic wrap was removed.
Picture courtesy of Brad Rops