Consistent Green Color Score Indicates Quality Hay

by Donald Westerhaus, Kemin Industries Forage Products Manager

Producing alfalfa hay with high feeding value and good visual appearance which includes numerous retained leaves and pliable stems depends upon drying conditions while cut hay is in a windrow. Hay producers always wonder:

(1) How long to wait before the windrowed crop can be baled?

(2) What storage issues they might face?

(3) What the likely feeding value will be after storage?

Over the years, countless producers and their fire insurance agents have learned what nature does with hay baled too wet. Naturally occurring fungi and bacteria in the hay respire and cause heating, with the severity directly correlated to the moisture level in the hay. To bale at moisture levels above 15-16% requires the use of a preservative such as propionic acid or a combination of organic acids to control microbial growth and hay degradation (Martinson, 2007). Likewise, producers' balance sheets know all too well what baling hay too dry does to the feeding value. In today's market, the difference in value between dairy quality hay and poor quality grinder hay can easily be $100/ton or more.

SO HOW CAN A PRODUCER DEAL?

During the 2005 growing season, an independent forage testing company (D. Sapienza, Ph.D., Sapienza Analytica, LLC, Slater, IA) and analysis laboratory (Dairyland Laboratory, Inc., Arcadia, WI) conducted a baled hay study in eastern Nebraska funded by Kemin Industries, Inc., using commercially-available propionic acid-based hay preservatives. The objective was to quantify the moisture level(s) at which the feeding value of hay could be preserved and still allow it to be safely stored in unwrapped, unsealed large, rectangular bales (1,100 lbs and 18 lbs/ft^3).

Six bales were made of each additive/application rate in each of two cuttings, first (May) and fifth (October). At each cutting, three moisture levels were compared: wet = greater than 26%, medium = 20-26% and dry = less than 20%. These were baled and stored for 21 days. Each bale was fitted with four temperature probes with one probe in each quadrant of the large face of the rectangular bale. The temperature probes were connected to a recording device and temperature readings were recorded every 20 minutes continually for 21 days. The data were then converted into Heat Units (HU). Treatments were compared based on HU.

HOW DOES HEATING AFFECT QUALITY?

Heat produced in bales of hay while curing is a dynamic process. This experiment confirmed that temperatures reached inside the bales mimic the daily cycles of the environment. However, in bales that overheated, the maximum and minimum temperatures inside the bales were higher than the average temperature of daily cycles of the environment.

In forage making, a heat unit is the above-average energy available to cause non-enzymatic browning commonly known as caramelization or Maillard Reaction in forages. Heat Units (HU) are calculated by the formula: HU = ((daily max T – daily min T)/2).

Ideal color scores (2.2-3.2)

Visual Score **FIVE**	Visual Score **FOUR**	Visual Score **THREE**	Visual Score **TWO**	Visual Score **ONE**
Extensive heat damage	Moderate heat damage	Good green coloring, low heat damage	Moderate drying damage	Extensive drying damage
HU > 350	HU >250	HU ~ 150	HU ~ 120	HU < 100
Crude Protein 19.5%	Crude Protein 18.6%	Crude Protein 20.9%	Crude Protein 20.7%	Crude Protein 20.9%
CP Digestibility 58%	CP Digestibility 62.3%	CP Digestibility 72.6%	CP Digestibility 69.3%	CP Digestibility 67.6%
NDF 44.8%	NDF 42.6%	NDF 34.3%	NDF 35.7%	NDF 35.4%
NDF Digestibility 22.2%	NDF Digestibility 25.8%	NDF Digestibility 33.6%	NDF Digestibility 36.9%	NDF Digestibility 24.9%

IN THIS TRIAL:

- There was a statistical advantage for the reduction of HU produced by bales made with less than 25% moisture.
- At these moisture levels, using a preservative showed a significant 13-unit reduction ($P<0.05$) in HU produced when compared to bales made with no additive.
- At less than 27% moisture, at least one preservative showed a significant lowering of HU produced ($P<0.05$) when compared to other commercial treatments each applied in accordance with their respective label recommendations.
- Hay bales, regardless of moisture content, experience a daily internal temperature variation by as much as 50-70 degrees within the bale and above ambient temperature. This is an important observation with implications for all hay producers for the following reasons:

  (1) Heat in bales produces heat-damaged protein (%ADICP or acid detergent insoluble protein) which lessens the feeding value of hay;

  (2) Heat can cause water to collect at the surface of the bale. This "surface water" can combine with oxygen in the air to enhance the chances for spoilage organisms to grow on the outer surface.
- No treatment was effective at or above 28% moisture.

WHAT DOES THIS MEAN FOR A HAY PRODUCER OR A HAY BUYER?

After 21 days in storage, bales from each treatment were cut in half, and each bale was evaluated using the visual scoring method described below. At least one preservative reached the goal of maintaining a visual green color score of 2.2-3.2, indicating minimal heat damage caused by baling and storing hay at moisture content between 18-22%.

Of course, the precautions for proper stacking and storage area management outlined by Martinson and used in this experiment must also be followed. From these results, a hay producer can feel confident that they have an alternative when baling hay at moistures between 18-22% due to marketing strategies or to unfavorable hay making conditions, knowing that the heat damage will be minimal and visual appearance will be appealing to a customer or an animal.

The color was also compared to crude protein digestibility as measured after incubation in rumen fluid for 12 hours. The NDF digestibility was measured after incubation in rumen fluid for 48 hours. The values illustrated in the table were measured during evaluation and should not be interpreted as a guaranteed analysis.

SUMMARY

Drying hay below 20% moisture reduces the incidences of heat damage. However, due to climatic conditions associated with first and fifth cuttings, there may be insufficient Heat Units to affect good drying. It appears from these findings, if a producer is making hay at a moisture content between 18 -22%, there are effective hay additives that when used according to label directions, increase the probability of achieving hay with green color and reduced heat damage, thus maintaining value to the stored crop.

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