EVALUATION OF SILICONE SURFACE-BASED HAY PRESERVATIVE FOR LARGE SQUARE BALES

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Kevin J. Shinners – University of Wisconsin

INTRODUCTION

A new product is being promoted for conserving large square bale (LSB) value when baled at 20 to 25% (w.b) moisture (Anon., 2011). The products active ingredient is food-grade silicone, which is intended to coat the plant surface and prevent mold from accessing the substrate within the plant. Since it is a surface treatment and not a volatile acid, it is reported that the long term preservation is superior to that of acid preservative (Tietz, 2011). The cost of the material is reported to be $3 – $6 per ton (Tietz, 2011). It is important that the proposed research on the effectiveness of this product at conserving hay value be conducted because this is a completely new hay preservative technology that may have some conservation advantages compared to acid preservative, and thus far there has been no independent assessment of the technologies effectiveness. Midwest hay producers need this independent assessment to make informed management decisions.

OBJECTIVES

The objectives of this research were to assess the effectiveness of applying the new silicone surface-based hay preservative on large square bales of alfalfa hay. Assessment was based on heating history during storage and dry matter loss during storage.

PROCEDURES

Second and third cutting alfalfa hay was be baled at the UW Arlington Agricultural Research Station. The hay was cut when it is approximately 20-30% bloom. Baling dates were July 15th and August 19th, 2013. Large square bales were baled with a Case IH model LBX333 baler at target moisture range of approximately 22 – 25% moisture. Three treatments were used: treated with propionic acid; treated with silicone preservative; and untreated control. Initial plans called for two different balers to be used because the two preservatives have different application requirements. However, the company representative for the silicone material indicated that the propionic application system on the baler could be used for both materials provided the system was well cleaned and rinsed between applications. Propionic acid was applied at rates between 0.8 and 0.9% of product (68% actual propionic acid) per unit mass of hay. Silicone based preservative was applied at a constant volumetric flow rate independent of hay moisture and the flow rate was set by the company representative who participated in both trials. Eight replicate bales were created per treatment, so a total of 24 bales were used in each of the two trials. Bales were weighed to the nearest 2 kg immediately after formation and then were bore sampled (50 mm bore, 60 cm depth) from both ends of the bale. These bore samples were combined, homogenized and then split into four sub-samples. Two sub-samples were dried for 24 h at
103°C for moisture determination and the remaining two were dried for 72 h at 55°C for later compositional analysis, if appropriate. Two thermocouple dataloggers were placed in each of the 24 bales per trial. The dataloggers recorded hay temperature at 2 h intervals throughout the storage period. The bales were stacked by treatment in an open front hay shed and remained in storage until January, 2014 – more than 5 moths in storage. The stacks were four bales high by two bales wide and to eliminate edge effects, the bales were surrounded on all sides by dry bales previously in storage. However, bales of different treatments were not separated from each other by dry bales (fig. 1).

When removed from storage, the bales were weighed and bore sampled as described above. Initial plans were to conduct compositional analysis and mold counts on samples collected from bales removed from storage. However, the DM loss and temperature profiles between treatments were not significantly different, so conducting lab analyses were considered irrelevant.

Figure 1 - Schematic representation of bale placement into open front hay shed.

RESULTS

The baler monitor was used by the company representative and the research team to determine when the appropriate range had been reached. Unfortunately in second cutting, the baler moisture sensor indicated a much greater moisture range than actual, so the second cutting bales were baled at much too low a moisture range to effectively determine the effect of preservative on maintaining bale quality (table 1). The average bale moisture was 12.0% (w.b.). As expected at this moisture range, the temperature profiles for the three treatments were not significantly different and the bale temperatures were generally very close to ambient (fig. 2). Dry matter losses were also not significantly different between treatments (table 1) and average bale losses were less than 2%, which would be expected given the very low moisture into storage.

Actual bale moisture was closer to the target range for third cutting bales with average of 25.3% across all three treatments. Bales treated with propionic acid exhibited less heating than the other two treatments (fig. 3), although the difference was only about 10-15°F. The temperature difference was maintained through the summer and fall months. The maximum bale temperature occurred about a week after baling, but did not exceed roughly 110°F. Temperatures need to exceed about 120°F before
serious forage quality losses and molds develop. Given the moisture level in the bales, it was surprising that the temperature rise was not greater. It is possible the thermocouple dataloggers were not placed deep enough into the bale. Dry matter losses were not statistically different at the 95% confidence level, but the control bales did have numerically greater losses by about 2 percentage units (table 1). The losses were lower than expected given the initial bale moisture. Shinners (2000) reported losses nearly double those reported in this study when large square bale moisture was in the range of 27 to 28% moisture.

Bales were taken apart and visual observations noted. Second cutting bales exhibited characteristics of bales formed with very dry hay. The stems were hard and brittle and there was considerable leaf displacement from the stems. There was no visual evidence of hay that had undergone Browning reactions (brown hay and caramel smell.) Third cutting bales exhibited characteristics of bales that had undergone heating in the center of the bale (fig. 4). In all three treatments, bales had a brown color in the center and a caramel smell, both indicators of Maillard reactions from heating. There were no visual differences between bales of different treatments.

In third cutting, the silicone preservative was mixed with water prior to transport of the baler to the field. The baler then sat idle at the edge of the field for some time while raking was completed and the hay finished drying to the desired moisture range. If the water-silicone mix separated during this idle time, it was possible that the propionic applicator pump was not able to adequately supply the silicone to the application nozzles. It is unknown whether any potential difficulty applying the silicone preservative when using the propionic acid applicator may have compromised the application of the material and the subsequent storage results.

Table 1.  Into storage and out of storage bale moisture and dry matter loss for large square bales of alfalfa with two different preservatives, stored 5-6 months in open front hay shed.

<table>
<thead>
<tr>
<th>Bale Treatment[a]</th>
<th>Moisture Content .. % w.b.</th>
<th>Dry Matter Loss % of total</th>
<th>Moisture Content .. % w.b.</th>
<th>Dry Matter Loss % of total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial</td>
<td>Final</td>
<td>Initial</td>
<td>Final</td>
</tr>
<tr>
<td>Control</td>
<td>14.1b</td>
<td>15.1b</td>
<td>3.1a</td>
<td>25.7a</td>
</tr>
<tr>
<td>Silicone</td>
<td>11.1a</td>
<td>13.7a</td>
<td>1.1a</td>
<td>25.2a</td>
</tr>
<tr>
<td>Propionic Acid</td>
<td>11.0a</td>
<td>13.8a</td>
<td>0.9a</td>
<td>24.8a</td>
</tr>
</tbody>
</table>

LSD[b] (P = 0.05)

1.0 0.8 3.1 2.0 1.0 2.4

[a] Silicone preservative was First Response from Poly-Excel (http://www.polyexcel.com/) and the propionic acid was applied at 0.8 to 0.9% by mass.

[b] Least significant difference – averages in columns with different markers are significantly different with 95% confidence interval.
Figure 2. Temperature profile for large square bales in storage for 6 months. Average bale moisture for all treatments was 12.0% (w.b.).

Figure 3. Temperature profile for large square bales in storage for 5 months. Average bale moisture for all treatments was 25.3% (w.b.).
Figure 4 - Hay color in interior of large bales with the different treatments indicated. Note brown color in center of the bales which is indication that heating took place in all treatments. Average bale moisture was 25.3% (w.b.).

CONCLUSIONS

When large square bale moisture was well below 15% at baling, temperature rise in storage was nominal and dry matter losses averaged less than 2% of total. Applying a preservative in this moisture range would be of little value. When bale moisture was greater than 25% at baling, there was bale heating across all treatments. There was less heating in the bales treated with propionic acid than the other two treatments, but temperature rise was not excessive and differences were not great. Bales treated with either acid or silicone preservative had roughly 1.5 percentage units less dry matter loss than the control bales, but none of the treatments had statistically different storage losses. Visual observations of the interior of the bales indicated that heating took place in all treatments and the hay color was similar across all treatments. Further research is needed to determine if there are significant differences in hay conservation between types of preservative.
SUGGESTIONS FOR FUTURE WORK AND EXPERIMENT IMPROVEMENTS

The results from this experiment were inconclusive and further research is needed. It is recommended that if further experiments are carried out, these improvements should be considered:

- Use two balers – one configured to apply propionic acid and the other to apply the silicone treatment. The difficulty applying the silicone preservative when using the propionic acid applicator may have compromised the results, so it is important to make every effort to insure correct material application in any future studies. This can best be accomplished by using the application equipment specifically designed for each material.
- Reduce the time between mixing of the silicone preservative and application to insure that separation does not occur.
- Increase the number of bales used in each treatment to increase the statistical power of the experiment and also to make larger stacks of bales in storage.
- Separate each treatment in storage with insulation to reduce opportunity for heat transfer from treatments with different temperature profiles.
- Place the thermocouple dataloggers deeper into the bale to capture temperature rise further from the bale edge and reduce edge influence.

REFERENCES

