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Hay Preservatives

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Introduction

Rainfall on mown hay will significantly lower forage yield and nutrient content. Shortening the field curing time reduces the risk from precipitation damage to the hay. Mechanical conditioning of freshly cut forage and laying out wide windrows are excellent methods to hasten field drying. Another tool for shortening the time from mowing to baling is to use a hay preservative which can allow hay to be baled at a higher moisture content. Hay preservatives can be used on legumes, grasses, and grass-legume mixtures.

Preservatives work by inhibiting or reducing the growth of aerobic microbes in moist hay. Without microbial growth, heating and the subsequent depression in digestibility does not occur. Most hay preservatives do not improve nutritional quality of the forage,but merely prevent the decline in quality caused by heat build-up from excessive aerobic microbial action.

Generally, small square hay bales with a moisture content of 20% or less will not spoil during storage. Round bales should not be made until the hay is approximately 18% moisture and large square bales should be 15% or less. If hay is baled at higher moisture contents than these, often it will become moldy and much of the feeding value will be lost. Hay with a moisture content of about 25% provides an excellent environment for growth of aerobic microorganisms. These microbes rapidly break down the nutrients in the forage resulting in a large increase in microbial populations. The resultant heat build-up causes a reaction to occur between proteins and carbohydrates which renders both less digestible. Protein digestibility can be reduced to almost zero with severe heating. Heating also causes losses in the amount of dry matter yield that is ultimately stored

The amount of heat necessary to produce the reaction depends on several factors. Generally, bale temperatures less than 100°F cause no problems, but bale temperatures above 150°F almost always severely reduce protein and carbohydrate digestibility. When bale temperatures remain between 100 and 150°F, the length of elevated temperature determines the amount of nutrient loss. Damage occurs more rapidly at higher temperatures. As temperatures increase above 150°F so does the risk of barn fires.

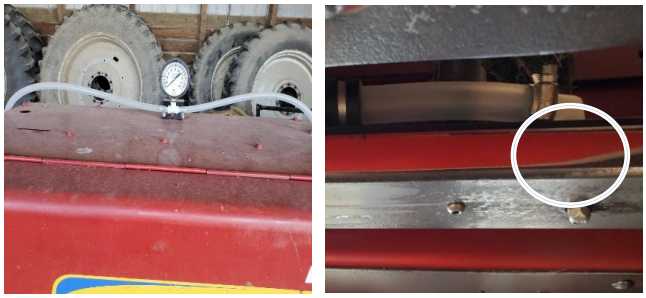
Chemicals and Application Procedures

Hay preservatives can be grouped into three categories: organic acids, ammonia-based, and microbial additives. Propionic acid is the most effective and most tested preservative available. It is often mixed with buffers to reductive corrosiveness, water, and coloring agents. Commercially available propionic acid-based preservatives are liquid formulations, so tanks and a spray application system must be added to the baler. Spray nozzles must be spaced so that the chemicals are distributed over all forage as it enters the baling chamber. Research at Cornell and the University of Illinois has shown propionic acid treated hay is safe for horses.

Organic Acids

Effectiveness of hay preservatives depends on good distribution within the hay package as well as adequate rate of the chemical. The amount of active ingredient that must be applied depends upon the moisture content of the hay. Small bales with 20-25% moisture should be treated with about 0.5% propionic acid (10 lb per ton as baled

basis). Application rate should be increased to 1% for hay with 25-30% moisture (20 lb per ton as baled basis). Most propionic acid-based preservatives are effective at inhibiting bacterial growth in hay up to 25% moisture, with variable effectiveness when hay is between 25 and 30% moisture. **No consistent response to any preservative has been observed with hay containing greater than about 30% moisture.** For adequate coverage, it is best to use a 50% solution and apply twice as much of the diluted acid so that the correct amount of active ingredient is applied. The main disadvantages of propionic acid are its corrosiveness and the cost of the equipment necessary to apply the liquid to hay. Newer buffered formulations have greatly reduced corrosion problems. Estimated cost of adding spraying equipment to a baler can start at $1000 and go up based on on-board moisture sensors and options such as automatic adjustment of application rates based on current moisture readings.



Left picture is plumbing and pressure gauge for acid applicator into bale chamber. Right is a nozzle in the bale chamber.

Ammonia Based

Ammonia is toxic to many microbes and can be a very effective preservative for moist hay (up to 30% moisture) when applied at 1% (dry matter basis). Lower quality straw, mature grass hay and corn stover can be ammoniated to 2-4% of the dry matter and be fed safely to ruminants. Higher quality forages such as alfalfa, immature grasses and cereal forages should only be treated with ammonia at the rate needed for preservation (1% of dry matter) because of the risk of toxicity to the animals consuming it.

The major disadvantage of using anhydrous ammonia as a preservative is that application is difficult. Devices have been made to inject anhydrous ammonia into large round bales. The recommended means of treating moist hay with anhydrous ammonia is to cover the bales with plastic and then inject the appropriate amount of ammonia. The ammonia may not become distributed uniformly throughout the moist hay; therefore, portions of the stack may spoil.

Urea can be converted to ammonia by bacteria normally found on the hay. Application of urea is much simpler than using anhydrous ammonia gas. Researchers have found that relatively large amounts of pelleted urea (5-7%, as baled weight basis) applied during baling can be an effective preservative for hay containing up to 30% moisture. Urea is only effective however if the hay is stored shortly after baling and covered tightly with plastic sheeting.

Applying the proper amount of ammonia is extremely important. Application rates below about 0.8% (dry matter basis) are much less effective than the 1% rate. **HIGH QUALITY HAY MUST NOT BE TREATED WITH MORE THAN 1% AMMONIA (DRY MATTER BASIS).** Applying more than 1% ammonia to high quality forages can result in the formation of an unknown toxic compound. Animals consuming ammoniated high-quality forage often exhibit hyperexcitability followed by death. The toxin is transferred into milk, so nursing calves and lambs also are susceptible to the toxin.

Microbial

Many types of microbial products have been promoted for use as hay preservatives, but very little positive or consistent value has been demonstrated with these products in independent research trials.

Storage Considerations for Preservative Treated Hay

Preservative treatment of hay does not reduce moisture content of the hay. Thus, hay baled with preservative that contains the higher moisture levels should not be mixed with field-cured hay that is lower in moisture, as the moisture will migrate from the wet preservative-treated bales to the drier bales and cause them to spoil.

Propionic acid-based products have been found to be the most effective, reliable, and practical for hay preservation. However, the preservative effect does not last indefinitely. A study looking at long-term storage of hay demonstrated that propionic acid-treated hay bales controlled dry matter losses during 4 weeks of storage but did not affect losses 20 weeks later compared with the untreated controls (Rotz et al., 1991). The propionic acid content in the hay will dissipate over time. Thus, it is important to feed preservative-treated hay in a timely manner. In general, the microbial products used as hay preservatives do no harm but have shown few benefits.

Advantages of Using Hay Preservatives

1. Preservatives allow hay to be baled at a higher moisture content which reduces the length of time hay lays in the field and lowers the risk of rain damage.

2. Baling at a higher moisture content reduces dry matter and nutrient losses during baling caused by leaf shatter.

3. Preservatives lengthen the potential baling period. Hay can be baled during early morning and late evening hours if dew does not raise moisture level above 25- 30%.

Disadvantages of Using Hay Preservatives

1. Unbuffered propionic acid is corrosive and can damage machines and injure workers.

2. Anhydrous ammonia is difficult to apply and is a hazardous chemical.

3. Some hay preservatives available currently may not work under many conditions. This is particularly true of microbial inoculants.

Summary

1. Propionic acid and anhydrous ammonia (application rates of about 1% of wet forage weight) are the only preservatives that consistently are effective on haycontaining 25-30% moisture.

2. Other preservatives may be effective on hay containing 20-25% moisture (follow manufacture directions), but many have not been scientifically tested.

3. Preservatives other than ammonia and urea do not improve feeding value but can reduce storage losses.

4. It is essential that the moisture content of the hay be known. Application rates of preservatives should be modified according to moisture content of the hay. Hay containing more than 30% moisture should not be baled as dry hay even with a preservative. It should be baled as baleage.

5. Cost of adding an applicator to a baler and the cost of the preservative needs to be evaluated against the increased value of hay that would have been rained on or would have heated and lost nutrient value.

6. It is important to feed preservative-treated hay in a timely manner, as the preservative effect begins to dissipate after one month of storage.

Useful References

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