

Preserving Baled Hay with Organic Acids

by Mike Rankin

Introduction

Weather patterns in the upper Midwest often make it difficult to field-cure hay below 20 percent moisture on a consistent basis. In some cases, growers may desire to harvest hay at higher moisture levels to reduce harvest losses from mechanical leaf shattering and improve forage quality. For these reasons researchers and hay producers are always looking for methods and technologies that will either accelerate drying time in the field or preserve desirable feeding characteristics of hay harvested above the optimum moisture level for safe storage.

One of the technologies used for preserving hay harvested above optimum moisture levels is to apply organic acids to the hay at harvest time. The use of organic acids has proven to be an effective strategy for preserving baled hay. Interest in using these products has increased with improvements in application equipment, product handling and corrosiveness, and increased use of large bale packages.

Why are hay preservatives needed?

When hay is baled and put into storage at moderate moisture levels (18 - 30%), a favorable environment exists for the growth of undesirable bacteria, fungi, and yeast. Both moisture and temperature drive the population growth of these microorganisms. Fungi such as *Aspergillus* and *Fusarium* can produce a wide range of toxic metabolites and greatly reduce hay palatability. Actinomycetes, a special class of heat-tolerant bacteria, provide the causative agent for Farmer's Lung Disease in humans.

Moist hay that is put into storage can suffer extensive dry matter loss because of increased plant respiration and microbial activity. There is typically a 1% loss of dry matter for each percent moisture loss during storage to reach a stable equilibrium. These losses are from the non-fiber components of the plants. As a result, a corresponding increase in the levels of acid

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detergent fiber (ADF), neutral detergent fiber (NDF), and acid detergent insoluble nitrogen (ADIN) also takes place.

Finally, wet hay that is put into storage has an increased risk of heating to the point of spontaneous combustion.

Organic acids, when applied at the proper rates, effectively control the development of molds on moist hay by preventing the growth of fungi and actinomycetes.

Do all organic acid products have equal effectiveness?

Not all organic acids or commercial organic acid products are created equal. Product effectiveness, cost per pound of acid, or concentration of active ingredient varies among the different products sold.

The most commonly used organic acid for hay preservation has been propionic acid. Not surprisingly, it is also one of the most effective. Some commercial products also contain a small percentage of acetic acid. However, acetic acid is a less effective hay preservative.

When purchasing a propionic acid product, be sure to read the product label for the actual percentage of active ingredient (ie. propionic acid). Some products contain as little as 15% actual propionate. Typically, the most cost-effective products are those with the highest concentration of propionate. Base purchase decisions on cost per pound of active ingredient and not cost per pound of product.

For many years, the major disadvantages to using propionic acid were its corrosiveness to machinery, pungent smell, and volatility. To address these problems, manufacturers developed buffered propionic acid products. Buffered propionic acid products are made by adding compounds such as ammonium hydroxide to the acid to form ammonium propionate. Several research studies have shown that the buffered product is equal in hay preservation qualities to that of unbuffered propionic acid. The tradeoff is that buffered products are more costly than those not buffered.

At what rate should organic acid preservatives be applied?

Bale moisture is the primary factor determining effective application rates. Inhibition of fungal growth requires a minimum level of acid concentration in the water component of the hay. An easy method to determine effective preservation rate (actual pounds of propionate per dry matter ton) is to take the moisture percentage of the hay and subtract 10. For example, hay baled at 25% moisture requires about 15 pounds of acid per ton of dry matter (25% moisture - 10 = 15 lbs acid required per ton).

Recommended application rates assume a hay product that is uniform in moisture. If some bales or parts of bales are significantly higher in moisture than the field average, application rates will need to be adjusted up to insure effective preservation of the entire hay lot.

To be effective, preservative must be uniformly distributed on the hay crop as it enters the baling chamber. This often means that multiple application nozzles are needed on the baler. Many hay producers dilute the propionic acid (or ammonium propionate) product with water and then increase flow rates through the application equipment to improve coverage on the crop.

Does bale type and density influence when organic acids should be used?

For small square bales, an organic acid preservative is recommended once moisture levels reach about 20%. Applying preservative to small square bales over 30% moisture is not recommended.

Large and medium square bales typically are more dense than small square bales allowing for less natural airflow through the stack. For this reason, an organic acid preservative should be used when baling large square bales or densely packaged round bales that are 17% moisture or above. Baling these larger bales at moisture levels over 25% is risky, even when a preservative is used.

Because of differences in on-farm moisture testers and bale densities, individual hay producers will need to develop their own "learning curve" relative to the use and effectiveness of organic acid preservatives for their specific situation.

How long will the preservative effects last?

Organic acids have proven to be reliable for inhibiting mold growth and preventing excess heating in hay. Results from several research studies suggest that the preservation effect initially gained from using organic acids is not long-term in nature. With time, the acid will dissipate from the hay. This can result in mold formation after 4 to 6 months of storage if enough moisture is present to support such growth. Using an organic acid preservative will not necessarily improve storage characteristics such as long-term dry matter loss or hay color.

What are the economics of organic acid use?

When figuring costs for using organic acid preservatives, include the expense for purchase and installation of application equipment and product cost.

Small square balers can usually be equipped with a tank, pump, and nozzles for \$250 to \$400. For large package balers, equipment costs range from \$500 to \$800.

Buffered acid products cost about \$1.10 per pound of active ingredient. Unbuffered products typically cost \$0.20 to \$0.30 less per pound. Therefore applying 10 lbs per ton of buffered product costs about \$11 per ton of treated hay. This does not include pro-rated equipment costs. However, these should be minimal on a per ton basis.

Organic acid preservatives will be most economical to use when large acreages are baled and the product is used discriminately to avoid rain damage on cut forage. They also have merit for custom hay balers who must please their customers with a quality product while at the same time baling large acreages in a relatively short time period.

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