Focus on Forage

Inoculants for Corn Silage

by Richard Muck

Introduction

Various spoilage microorganisms (bacteria, yeasts and molds) readily grow on crops going into a silo, causing losses in dry matter and quality. To prevent these various microorganisms from growing, two conditions are needed in the silo: an oxygen-free (or anaerobic) environment and a low pH. Many of the oxygen-requiring (aerobic) microorganisms that heat the silage as well as causing losses cannot be stopped by low pH alone. These microorganisms can only be stopped by sealing the silo well to keep out air. On the other hand, bacteria responsible for poor fermentations such as clostridia are stopped by dropping the pH of the crop sufficiently to prevent their growth.

The lowering of silage pH happens naturally under most circumstances. This is due to lactic acid bacteria on the crop fermenting sugars to lactic and acetic acids as well as to alcohol and several other minor compounds. Lactic acid is the preferred product of fermentation because it is a strong acid. Lactic acid also contains almost the same energy as the original crop sugars, and it can be fermented by rumen microorganisms. The speed and efficiency of the natural fermentation process is highly variable, depending on the number of lactic acid bacteria on the crop, the particular strains of lactic acid bacteria, and the temperature and sugar content of the crop.

Inoculants are silage additives containing lactic acid bacteria that have been selected to grow rapidly and efficiently (producing primarily lactic acid) on crops in the silo. Consequently, they help to insure a good fermentation in the silo. However, the primary economic benefits are in improved dry matter recovery from the silo and improved animal performance.

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Are inoculants really needed on corn silage?

Inoculants have been successful less frequently in corn silage than in hay-crop silages. Research studies show that inoculant treatments lead to fermentation improvements approximately two-thirds of the time in hay-crop silages as contrasted with only 40% of the time in corn silages. There are two primary reasons for the reduced response in corn silage. First, the natural population of lactic acid bacteria on corn at ensiling is on average 10 times higher than the natural population on alfalfa. This makes it more difficult for the inoculant to overwhelm the natural bacteria in corn silage and produce an effect. Second, natural fermentations in corn silage typically are high in lactic acid, low in acetic acid, and result in a low pH (3.8-3.9). With such a good natural fermentation, it is difficult for an inoculant to make substantial improvements in fermentation.

When the inoculant does succeed in improving fermentation, reductions in bunk stability have been frequently observed in research studies. Because bunk stability is already a problem in naturally fermented corn silage, any additive that potentially makes the situation worse is not particularly attractive.

Together, these factors indicate that inoculants will not be as profitable in making corn silage as in hay-crop silage. This in turn suggests that particular care in selecting and using inoculants will be required if you decide to inoculate corn silage.

Will inoculants reduce corn silage losses in the silo?

When the inoculant bacteria improve fermentation, dry matter losses from the silo decrease 1-2 percentage units on average. In other words, dry matter losses in a well-managed bunker silo would typically be reduced from 15% to 13-14% by inoculation. This decrease in dry matter loss is largely due to a shift in fermentation. There is no dry matter loss when lactic acid bacteria ferment sugar

only to lactic acid. In contrast, fermentation that produces lactic acid plus alcohol or acetic acid results in up to a 24% loss of the original sugar.

Will inoculants improve bunk stability of corn silage?

While these products are often marketed as improving bunk stability, research studies show that inoculants generally have little effect on this aspect of silage quality when considering all ensiled crops. The reason for this is the inoculant's effect on fermentation. Both lactic and acetic acids (primarily acetic acid) help inhibit the growth of spoilage microorganisms that cause heating in silage. Thus reducing the acetic acid content has a negative effect on bunk stability. However, lowering pH makes the acids present in silage more effective at inhibiting spoilage microorganisms. In corn silage, it is difficult for an inoculant to produce a much lower pH than that from a natural fermentation. The net result is that bunk stability in corn silage is often reduced relative to that produced by a natural fermentation.

Inoculant manufacturers are aware of this problem and are working to develop new inoculants that resolve this problem. Several new corn silage inoculants are available, but there are insufficient data at present to know if they consistently improve bunk stability.

Will inoculants increase corn silage digestibility and intake?

The shift in fermentation produced by inoculants should increase silage digestibility similarly to the improvements in dry matter recovery. In addition, research has documented that at least several products have improved fiber digestibility. The reason for this is not known. These improvements in digestibility have not always led to improvements in intake. A recent survey of inoculant studies in all silage crops found that intake was improved in only 21% of the animal studies whereas as fermentation was improved in 60% of the cases.

Will corn silage inoculants increase milk production?

Increases in animal performance have been observed more often than increases in intake. A recent survey of inoculant studies in all silage crops found milk production improved in about half of the studies. In studies where milk production was improved, milk production increased on average 3 lbs/cow/day. While most of the studies were with hay-crop silages, similar improvements are likely in corn silage.

Under what conditions will a corn silage inoculant be most successful?

We know much less about variation in the population of naturally-occurring lactic acid bacteria on corn than we do on alfalfa. Typically, the average population on corn at harvest is 10 times higher than on alfalfa so that inoculants are less successful on corn silage. Times when an inoculant is more likely to be successful are in immature corn, overly dry corn, and the day after a killing frost. The limited research data available suggest that these may be conditions where the natural population may be lower and/or less competitive than the inoculant bacteria.

What is the correct application rate?

The labeling of inoculants is highly variable and makes comparing products difficult. What is important is the number of lactic acid bacteria applied per unit of crop. One should buy a product that applies at least 90 billion live lactic acid bacteria per ton of crop as fed or 100,000 per gram of crop. Some products tell you how many bacteria are in the bag or bottle. In those cases, you will need to calculate how many will be applied to the crop. Higher numbers than these minimum rates should be better but are not always so.

What organisms should be present in a silage inoculant?

Inoculants may contain one or more strains of lactic acid bacteria. The most common is *Lactobacillus plantarum*. Other *Lactobacillus* or *Pediococcus* species may be present; also *Enterococcus faecium* is common. Rarely, a *Bacillus* species may be present to improve bunk stability. Be skeptical of products that contain other species.

Are there performance differences between specific strains of an organism?

Yes. For example, not all *Lactobacillus plantarum* strains grow at the same speed. Some *L. plantarum* strains may grow better on alfalfa, others better on corn. Some strains may grow better under drier conditions or higher temperatures than others, etc. Because of these differences, it is important to use a product labeled for the crop that you are ensiling. If a product is labeled only for corn silage, don't use it on alfalfa and vice versa.

Is there a performance difference between dry and liquid products?

Both dry and liquid products can be effective, but liquid application has some advantages over dry application. First, these bacteria cannot move around. They grow where they are placed. Therefore, inoculants must be applied as uniformly as possible to maximize effectiveness. A liquid sprayed on the crop at the chopper provides the best opportunity to distribute the inoculant uniformly and mix it thoroughly with the crop. Second, the bacteria in a liquid product should be able to begin working faster than a dry product, where the bacteria need to be moistened by plant juices before they can begin to grow. Third, most inoculants need to be kept cool and dry prior to use in order to maintain the activity of the bacteria. This is easiest with the liquid applied products that come in small packages that can be placed in a refrigerator.

There are two issues of concern in using liquid products. First is the water used for diluting the product. If your water supply is chlorinated, the chlorine can kill the lactic acid bacteria if the chlorine level is too high. Use a pool tester to be sure that the chlorine concentration in the water is less than 1 ppm. If it is above 1 ppm, either allow the dilution water to sit open to the air overnight (so that the chlorine level is reduced), or look for a product that has compounds to neutralize the chlorine. Second, once a product has been diluted, it generally needs to be used within a 24-h period. Some products are diluted the night before use; these should be used within 24 h of when they are ready for application. Consequently, there can be some product wastage if the amount harvested is less than expected due to weather, breakdowns, etc.

How can I tell if I am purchasing a good product?

It is difficult to compare one inoculant with another, but there are some things to look for in purchasing a product. First, look for a product that guarantees to supply at least 90 billion live lactic acid bacteria per ton of crop. Second, be sure to buy a product that is labeled for corn silage.

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