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Harvesting and Feeding Drought-Stressed Corn

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Introduction

How to best harvest, store and use drought-stressed corn is a problem dairy and livestock producers may encounter at one time or another. The severity of the drought, cultural practices, plant growth, plant maturity and livestock feeding regimes are factors that influence how to harvest, store and feed most effectively the drought-stressed corn.

Dairy and livestock producers attempting to salvage usable feed from their drought-stressed fields of corn must not only be wary of poisoning their livestock, but poisoning themselves as well. Accumulation of nitrates in drought-stressed corn can cause nitrate toxicity in animals and ensiled drought-stressed corn can produce poisonous nitrogen gases during the fermentation process, which may be lethal to livestock and humans.

When To Harvest

If a drought-stressed corn plant without an ear has tasseled and shed pollen, it will be barren. Where pollination has occurred, small white blisters are visible about one week after pollination. These kernels will continue to develop to maturity if the plant gets water. If there is any chance the drought-stressed plant will form ears, delay harvest. If however, ears are not going to develop, emergency feed is needed or the failed acreage must be replanted, the crop may be harvested early.

Harvested early or at physiological maturity, drought-stressed corn has the potential to be toxic due to the accumulation of nitrates. Nitrates accumulate in plants only when: 1) there is a large amount of nitrate in the soil, or 2) some factor interferes with normal plant growth. High rates of nitrogen fertilization and drought conditions are the most important factors contributing to nitrate buildup in plants. Generally there is a direct response in plant nitrate concentration to increasing fertilizer nitrogen. Nitrate accumulation is greater from nitrate fertilizers than from ammonium sulfate or urea. Nitrate accumulation also is greater with delayed application of fertilizer.

Under unfavorable conditions, such as drought, nitrates accumulate in the stalks, stems and other conductive tissues. The highest concentration of nitrate is in the lower part of the stalk or stem. For example, the majority of the nitrate in drought-stricken corn plants can be found in the bottom third of the stalk (see Table 1). If, however, moisture conditions improve, the conversion process of nitrates to plant proteins accelerates and within a few days nitrate levels in the plant return to normal. The concentration of nitrates relative to the plant parts may play a key role in deciding the level of cut during harvest, to reduce the threat of nitrate toxicity.

Table 1. Nitrate nitrogen (NO_3N) in 28 samples of drought-stressed corn

Plant Part	ppm NO_3N[a]
Leaves	64
Ears	17
Upper ⅓ stalk	153
Middle ⅓ stalk	803
Lower ⅓ stalk	5,524
Whole plant	978

[a] ppm = parts per million
Source: University of Wisconsin

Not all drought conditions cause high nitrate levels in plants. If the supply of soil nitrates is in the dry soil surface, plant roots will not absorb nitrates. Some soil moisture is necessary with the nitrates for absorption and accumulation.

Like plants, ruminant animals also use nitrogen in nitrates to make protein. Conversion is made by bacteria in the rumen. Nitrite, one of the intermediate products in the conversion of nitrates to protein, is the cause of nitrate poisoning. Nitrate toxicity occurs when high nitrate levels in the feed overwhelm the animal's digestive system to the extent that the rate of conversion of nitrate to nitrite is faster than the conversion of nitrate to ammonia (which is incorporated in amino acids and protein). When this happens, nitrite accumulates and is absorbed into the bloodstream. There it reacts with oxygen-carrying hemoglobin, changing it into a form (methemoglob in) that cannot transport oxygen to the lungs and body tissues, and the animal literally suffocates.

Symptoms of nitrite toxicity in animals include: increased pulse rate, quickened respiration, heavy breathing, muscle tremors, weakness, staggered gait and blindness. Mucous membranes will also turn blue and feel cold to the touch (cyanosis). Typically, animals die 3 to 4 hours after the onset of initial symptoms.

If poisoning is suspected contact your veterinarian immediately. Keep affected animals as quiet and comfortable as possible until treatment can be administered.

How To Harvest

There are three options for harvesting drought-stressed corn: 1) green chopping to feed as soilage, 2) baling to feed as hay, or 3) ensiling to feed as silage. The timing of the drought may play a role in your decision to green chop, bale or ensile the crop.

Green chopping

It is possible to graze or green chop drought-stressed corn, however, this method of harvest is not recommended because of potential nitrate toxicity.

If drought has occurred early in the growing season and the corn must be grazed or chopped as an emergency feed, caution should be used in giving this feed to young, pregnant or nursing animals. In all cases make sure animals are provided with a supplemental source of energy such as grain. Energy from the grain helps to complete the conversion of nitrate to ammonia in the rumen, reducing the threat of nitrate toxicity.

Baling

Ensiling drought-stressed corn is preferred to baling since the fermentation process of ensiling reduces the potential for nitrate toxicity. However, when drought occurs early rather than late in the growing season, baling may be the preferred and more practical method of harvest.

The reasons why baling may be more practical and thus preferred to ensiling include: 1) use of corn harvesting equipment on short corn may be difficult and not economical, 2) direct cut short corn will be wet and seep once ensiled, and 3) yields will be insufficient to obtain necessary compaction in a trench or upright silo to achieve proper fermentation to preserve the feed as silage. If it will not be difficult or costly to use corn harvesting equipment, then certainly silage seepage and improper fermentation due to poor packing are sufficient justification for choosing to bale rather than ensile the crop.

Seepage, due to wet silage and/or poor packing, are two conditions which alter the normal fermentation process of silage affecting its nutritive value and palatability. If either or both of these conditions occur the entire crop may be unfeedable to all livestock.

To circumvent the problems of poor fermentation and a failed silage crop, harvest the corn for hay rather than for silage. If the corn is harvested for hay rather than silage, a lower level of cut can be obtained with a mower-conditioner than with a forage harvester, which gives a somewhat higher yield from a yield-depressed crop. However, if the stalk is cut lower there is a greater chance for increased nitrate content. Harvesting high nitrate corn as hay will not reduce the level of nitrates in the corn. A crop high in nitrates prior to baling will be high in nitrates after baling and during storage. Unlike the fermentation process of silage making, the hay curing process does not reduce the levels of nitrates in drought-stressed corn.

All drought-stressed corn used as hay should be tested for nitrates. To properly sample baled corn, core (using a core sampler) 18 to 20 bales per field. The more accurately the feed is sampled the more reliable the nitrate analysis.

An additional benefit to corn as hay rather than silage is flexibility of feeding. Hay of differing nitrate content can be fed more readily to more animals in varying quantities than can silage of a given nitrate level that must be fed off at a specific daily rate to prevent spoilage.

Ensiling

If drought occurs later in the growing season and the corn can be harvested so as to achieve proper fermentation, ensiling is the preferred method of harvest.

One-fifth to two-thirds of the nitrate accumulated in the plant may be dissipated during fermentation. Note in Table 2 that ensiling corn forage reduced nitrate concentration by about one-third. Because fermentation takes 14 to 21 days for completion, drought-stressed corn silage should not be fed for at least 3 weeks after the silo has been filled. The percentage of moisture in the plant influences the length of fermentation. The optimum is 60 to 65 percent moisture, and the minimum for ensiling corn suspected of being high in nitrate is 55 percent moisture. Corn ensiled at less than 55 percent moisture results in reduced fermentation activity and less breakdown of nitrate. Moisture levels above 70 percent will result in seepage losses and production of a foul smelling unpalatable silage.

Table 2. Effect of ensiling on nitrate concentration in corn silage

	Nitrogen applied per acre		
Corn fed as	0 lb	200 lb	800 lb
Green forage			
Nitrate (ppm)[a]	602	2,319	4,438
Silage			
Nitrate (ppm)	380	1,468	2,861
Decrease with ensiling (percentage)	37	41	36
pH	3.9	3.8	3.8

[a] ppm = parts per million

Nitrate values on dry basis. To convert values from ppm to percent, move the decimal point four places to the left—i.e., 602 ppm is .06 percent.

Source: Purdue University

To estimate moisture content of silage use the rapid "grab test" if a more precise method of determining moisture is not available. A handful of finely-cut plant material should be squeezed as tightly as possible for 90 seconds. Release the grip and note the condition of the plant ball in the hand:

- If juice runs freely or shows between the fingers, the crop contains 75 to 85 percent moisture.
- If the ball holds its shape and the hand is moist, the material contains 70 to 75 percent moisture.
- If the ball expands slowly and no dampness appears on the hand, the material contains 60 to 70 percent moisture.

- If the ball springs out in the opening hand, the crop contains less than 60 percent moisture.

Using silage preservatives will not affect the breakdown of nitrates during fermentation. Bacteria or enzyme-type preservatives may decrease fermentation time, but they will not significantly alter the 20 to 60 percent breakdown of nitrates that occur naturally in properly fermented silage.

Purdue University studies have shown that the addition of 20 lbs of limestone per ton of silage going into the silo further reduced nitrate levels. Addition of more than 20 pounds per ton adversely affected fermentation and quality of the silage. Limestone tends to raise pH (make more basic), which, in turn, can reduce silage quality.

Nonprotein nitrogen (NPN), such as urea, should be added to silage only if good quality silage can be produced. If the silage does not ferment (too dry), losses will occur as ammonia gas. If seepage occurs (because silage is too wet), the NPN will leach out since it is water soluble. Drought-stressed corn should not be supplemented with NPN. Also, since immature corn is high in nitrates and NPN, the amount of urea in the total ration should be limited.

Grains (carbohydrates) added to silage will improve fermentation and silage quality if the silage is ensiled at the proper moisture level and the silage is well packed. Even with the benefits of improved fermentation and silage quality, the cost of adding sufficient grain to the silage may be prohibitive.

Once ensiled and completely fermented, the silage should be sampled for nitrate analysis. Be careful when sampling to ensure you obtain a representative sample. You may obtain grab samples for 3 to 4 days, mix the samples and then send one sample for analysis. Refrigerate all samples and minimize the time between the final sampling and the receipt of the sample at the laboratory.

The production of lethal, poisonous nitrogen oxide gases during the fermentation of nitrate-containing silage cannot be ignored. These gases are lethal to humans and livestock and may occur within 12 to 60 hours after silo filling begins. These gases are heavier than air and will accumulate above the silage in the silo, in the silo chute, or in the silo room and flow out the silo juice drain.

The first lethal gas formed is nitric oxide, which is colorless and odorless. Nitric oxide is then converted to nitrogen dioxide, which is yellowish green. Further oxidation of nitrogen oxide forms nitrogen tetraoxide, which has a reddish-brown color and typically smells like laundry bleach. These gases will leave a characteristic yellowish-brown stain on wood, silage and other materials.

Do not enter a silo without first running the blower for 10 to 15 minutes to completely ventilate the silo, chute and silo room. Follow this procedure during the silo filling process and for 2 to 3 weeks following filling. Also, leave the chute door open at the surface of the silage to prevent the accumulation of these gases in the silo.

If exposed to nitrogen oxide gases call the doctor immediately. Prompt medical treatment may minimize injury or prevent death.

Feeding Drought-Stressed Corn

The results of several feeding trials have shown that corn silage made from plants with no ears or partially filled ears had 65 to 80 percent of the value of normal corn silage on a dry matter basis when comparing feed efficiency, milk production and growth rate. However, the moisture content of silage made from barren stalks is high, which reduces daily dry matter intake and, in turn, animal performance.

Typically drought-stressed corn is lower in energy content and slightly higher in protein than normal corn silage. Badly damaged corn, corn with no ear development, may be quite low in energy and digestibility. Indicated in Table 3 is the expected nutrient composition of different corn silages.

Table 3. Nutrient composition of various corn silages

Type of silage	DM (%)	CP	ADF	TDN
		— percentage dry matter —		
Normal, dent stage	35	8.5	28	68
Drought-stressed, few ears	30	9.9	36	60
Drought-stressed, no ears.	22	11	40	56

The altered nutrient composition of drought-stressed corn emphasizes the importance of forage testing as part of the process of formulating balanced rations. Knowing the nutrient content of drought-stressed silage can save purchased feed dollars and enhance animal performance.

Recommended Practices

The timing of drought may influence how to best harvest and feed drought-stressed corn. To achieve the maximum crop yield and reduce the threat of nitrate toxicity we recommend the following:

1. To reduce the risk of nitrate toxicity do not graze or green chop drought-stressed corn.
2. If drought-stressed corn has to be grazed or green chopped avoid feeding it to young, nursing or pregnant animals. Provide a source of energy, such as grain.
3. If proper fermentation cannot be achieved due to low crop yield, drought-stressed corn may be baled for hay. However, high nitrate corn will remain high in nitrates after baling as the curing process does not reduce the level of nitrates.
4. If yield is sufficient to ensure proper fermentation, ensiling is the preferred method of harvest. Ensiling drought-stressed corn will reduce the risk of nitrate poisoning.
5. If the drought-stressed corn is ensiled, take proper precautions to avoid nitrogen gas poisoning of humans and livestock.
6. Test all drought-stressed corn that is to be fed for nitrate level. Remember, proper sampling technique is important for obtaining a reliable nitrate analysis test.

7. Once tested, follow recommended feeding guidelines. Introduce nitrate-containing feeds slowly into rations. Provide adequate protein and energy (in the grain mix) to enhance the conversion of nitrates to ammonia in the rumen. Be careful when feeding nitrate-containing feeds to replacement animals and pregnant animals. Avoid feeding these animals nitrate-containing (>0.44%) nitrate ion) feeds, if possible. Feed all animals a balanced ration.
8. If cattle exhibit symptoms of nitrate poisoning, immediately call your veterinarian and remove animals from feed.

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