

A Tragedy In Winter

by Dr. Carl S. Hoveland

A Georgia cattleman drives into one of his pastures early one frosty January morning and finds ten cows lying dead. Pastures were very short so the day before he had put a big bale of high-quality pearl millet hay for the cows to eat. Later, the veterinarian diagnosed nitrate toxicity. A terrible loss. Why? Maybe it was ignorance, more likely it was failure to take the necessary precautions at the right time to avoid such a serious loss. Now during the autumn season is a good time to take stock of hay supplies and protect oneself from potential livestock losses as a result of nitrate toxicity.

The Problem

Pasture and hay plants take up nitrogen from the soil, primarily in the form of nitrate. Under good growing conditions, the nitrate is rapidly converted into nitrite, then to ammonia, then into plant proteins. However, when plant growth is slowed or stopped because of drought or frost, nitrate continues to be taken up by the plant but it cannot be changed into other forms of nitrogen fast enough and nitrate accumulates. When the animals eat this forage as hay or pasture, nitrate poisoning can occur. Although drought and frost are the primary factors causing plants to accumulate nitrate, small grains may accumulate toxic levels during periods of very cloudy weather. Also, many weeds can accumulate toxic levels of nitrate after they have been sprayed with 2,4-D or 2,4-DB herbicides.

Certain plants are more likely to accumulate toxic levels of nitrate than others. Pearl millet, sorghum-sudangrass, johnsongrass, and oats are known to be accumulators. Grasses that have been highly fertilized with nitrogen and harvested under severe moisture stress such as bermudagrass, corn, forage sorghum, or tall fescue may also have toxic levels. Weedy hay may accentuate the problem as certain weeds such as pigweed, smartweed, thistle, lambsquarter, goldenrod, nightshade, and stinging nettle are known accumulators of nitrate.

Nitrate levels can change rapidly from day to day, depending on soil moisture

levels or frost. Once cut for hay, nitrate levels do not change appreciably. However, ensiling high nitrate forage will cause a portion to be converted to a brown gas and lost. Thus, silage is safer to feed than hay but there may be some danger.

The Animal Response to Nitrates

Nitrates are relatively non-toxic to cattle but after their conversion to nitrite in the digestive tract there is trouble. The nitrite ion oxidizes iron in blood hemoglobin to the ferrous state, forming methemoglobin, which is unable to function as an oxygen carrier. If enough of the hemoglobin is changed to methemoglobin, the animal will die from lack of oxygen and suffocate.

Sublethal symptoms of nitrate poisoning are seldom apparent to a cattleman. There is abdominal pain, diarrhea, muscular weakness, incoordination, accelerated heart rate, sometimes convulsions. Nitrate in the diet at moderate levels will cause reduced milk production, lowered rate of gain, and reproductive problems. Death may occur in a short time after consuming forage with high levels of

nitrate. Dead animals will have discolored, dark, chocolate color blood. Animals in poor condition on low energy diets will gorge themselves and increase the severity of the problem on a given level of nitrate. Animals that have gradually increased levels of nitrate in the diet tend to be able to tolerate higher levels than animals first exposed to the high levels.

How to Handle the Problem

The most important thing a cattleman can do to protect against cattle losses from nitrate toxicity is to test hay that was harvested during severe drought or just after frost. This is critical in making decisions on how to feed the hay or if it can be fed at all with safety. Take several representative samples, mix well, and send it to the Soil Test Laboratory in Athens. Your county extension office has information on how to sample your hay and send it to the laboratory. When you receive your report from the laboratory, it will give the level of nitrate nitrogen ($\text{NO}_3\text{-N}$) in the forage in parts per million (ppm) on a dry matter basis. In

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Nitrate nitrogen ppm	Response
0 to 1,500	Generally safe to feed. In upper part of range, use caution in feeding pregnant or young animals.
1,500 to 5,000	Limit toxic hay to one-half of dry matter intake. Provide extra energy. Provide supplemental vitamin A at 1,500 I.U. if nitrate containing hay is fed for a month or more. Do not feed non-protein nitrogen supplements.
5,000 +	TOXIC! Do not feed this hay free-choice. Feed containing such levels of nitrates may be ground and mixed if the nitrate-containing hay is no more than 15% by weight of the total ration. If you can't do this, sell the hay to the highway department or an ornamental nursery for mulching purposes. Dumping it in a gully on your farm is another option if cattle do not have access to the hay.

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practical terms, the report will be able to assist you in determining what to do with the forage.

If you send your hay sample to a commercial laboratory, be sure to check carefully how they report nitrate levels. Some laboratories report in other units such as NO_3 or KNO_3 so the toxic ranges will differ from that shown above.

Finally, to summarize what to do with feeding nitrate-toxic hay:

(1) Consider the class and condition of animals consuming the hay. Animals in poor condition will be affected by lower levels of nitrate than animals in excellent condition. Lactating cows and stockers may show reduced performance.

(2) Do not feed nitrate-toxic hay to hungry cattle or they will eat excessive amounts in a short time.

(3) Dilute the diet by feeding a non-toxic hay or by limiting the time animals have access to the toxic hay. If a big bale of high-nitrate hay is put alongside a low-nitrate bale, some animals will eat only one type and toxicity may result. Nitrate converts to nitrite in hay that has become wet, and this makes the hay more toxic.

(4) Feed an energy supplement. Feeding corn grain will increase the rate of nitrate metabolism in the rumen, thereby detoxifying it.

(5) If you observe symptoms of nitrate toxicity, give an intravenous injection of methylene blue solution immediately. This reducing agent converts methemoglobin to oxyhemoglobin and reverses the effect of nitrite. Treatment should be repeated in severe cases.

Conclusion

The tragedy reported at the beginning of this article doesn't have to happen. Keep records on when and under what conditions your hay was grown and harvested. If you have any suspicion that the hay might be toxic, sample and have it tested for nitrates. The loss of one cow makes the cost of a few nitrate tests seem cheap. Last summer's severe drought in many parts of the state make it likely that there will be quite a few bales of nitrate-toxic hay on farms this winter feeding season. Test your hay and be safe! (Contact Dr. Hoveland at Crop & Soil Science Dept., University of Georgia, Athens, GA 30602, or e-mail: hoveland@uga.cc.uga.edu)