

What is Nitrite Toxicity?
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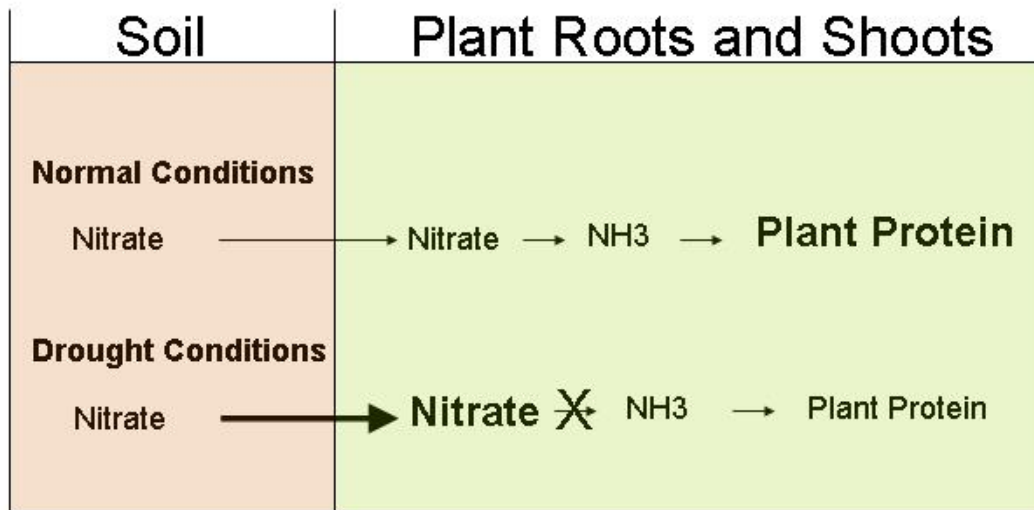
Many beef producers are familiar with high nitrates in forages and their toxic effects in cattle. Probably few are familiar with nitrite toxicity. Nitrate and nitrite toxicity are exactly the same syndrome and these terms can be used interchangeably. Nitrates are the compound that accumulates in plants, but the absorption of nitrites actually affect cattle. Regardless of which term is used, the economic consequences of nitrate toxicity are severe. Every year cattle in Georgia are lost because of nitrate poisoning from pastures or hay. Awareness of factors that cause forages to accumulate nitrate levels can help producers to avoid this problem. In this article, I'll discuss what happens in both plants and animals to cause nitrate accumulation and toxicity. I'll also discuss potential plant and animal management alternatives to prevent these problems.

Nitrate accumulation - the plant perspective:

To determine how to prevent or offset nitrate toxicity, it's important to understand why nitrates accumulate in plants and how they affect the animal. Under good growing conditions, plants absorb nitrates from the soil and convert them into plant proteins. This can be demonstrated in the first line of Figure 1. Some of the factors that influence nitrate accumulation in plants are plant stress, heavy nitrogen applications and plant species.

Any stress that decreases plant growth can also increase nitrate concentration. The most common cause of nitrate accumulation is drought stress. I've diagrammed normal plant nutrient uptake and nitrate conversion in the first line of Figure 1. Nitrates are normally taken up through roots, reduced, and deposited in plant proteins. During drought conditions, plants absorb nitrate from the soil, but are unable to reduce this nitrate and convert it into protein (Line 2 of Figure 1). As a result, plant nitrates increase to toxic levels.

Figure 1. Nitrate routes in plants.



Nitrogen fertilizer application may also increase nitrate content of plants. High nitrogen rates can overwhelm a plants ability to convert nitrate to protein and cause nitrate concentrations to rise. In normal growing conditions, plant nitrate levels should only be slightly elevated for one to two weeks after fertilization. However, when plants are stressed or high nitrogen rates are applied, dangerous nitrate amounts can be present until plants "grow out" of the nitrate buildup.

Plant species also affects the potential for nitrate poisoning. Several plant species are notorious for accumulating nitrates. Nitrate toxicity often occurs when cattle graze or are fed summer annual forages. Sorghum, sudangrass and sorghum-sudan hybrids are most commonly reported to have high nitrate levels, and millets also accumulate nitrates. In fact, according to data from Oklahoma, millets may accumulate more nitrates than sorghum-sudan hybrids. This is not a reason to avoid pearl millet because in much of Georgia millet has several advantages over sorghum-sudan hybrids. For example, pearl millet will produce much higher yields than sorghum-sudan in acidic and droughty soils. Pearl millet also does not cause prussic acid poisoning which will be discussed in a later article.

In addition to summer annuals, several common weeds (i.e. johnsongrass) can also accumulate nitrates. Cattle will often select johnsongrass over

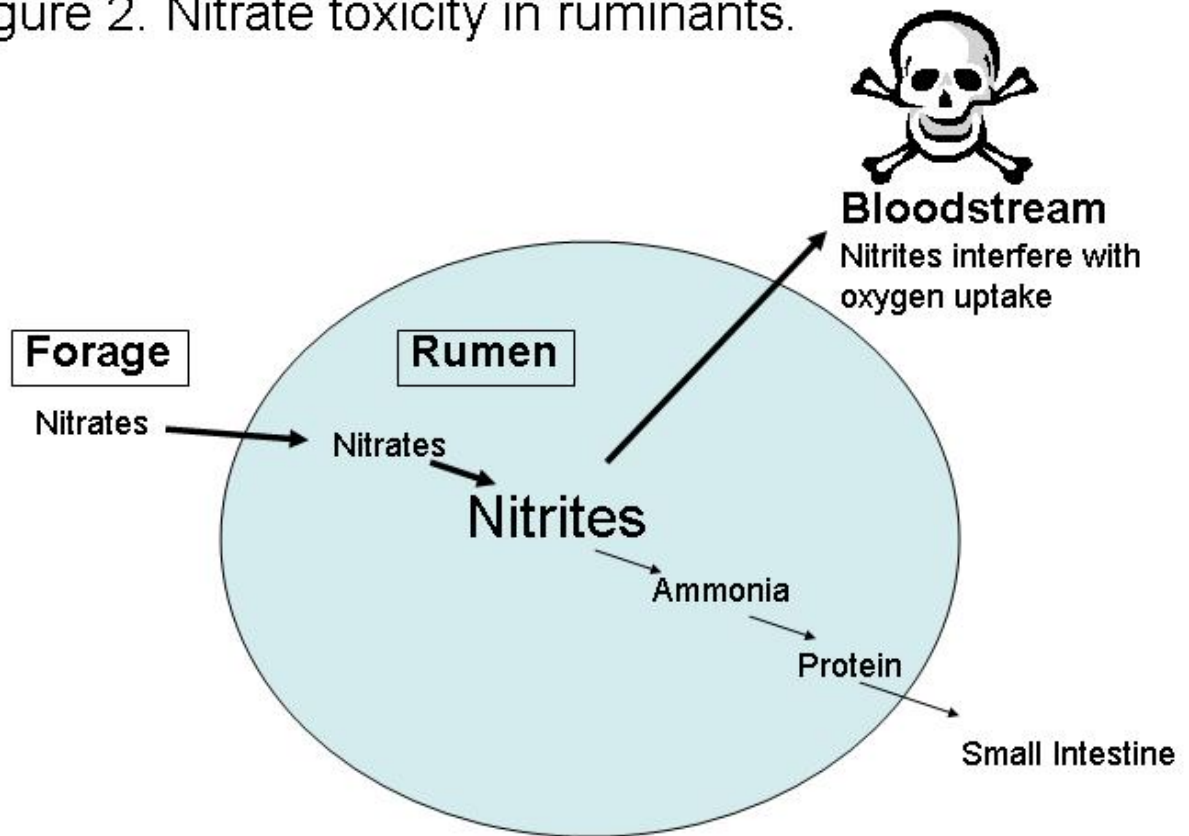
bermudagrass under grazing conditions or consume large amounts of johnsongrass in contaminated hay so be careful with nitrate prone forages harvested under dry conditions.

Nitrate toxicity- the animal perspective

High nitrates (NO_3) in plants are not the true cause of animal toxicity! Nitrites (NO_2) actually cause the animal symptoms. While it may seem like I am "splitting hairs" this interesting trivia translates to important management tools that can be used to prevent nitrate poisoning. To comprehend these management tools, processes in the digestive tract must first be understood.

When cattle, sheep or goats consume normal levels of nitrate (less than 2500 ppm) in forages, no problems are observed. In the rumen, nitrate is converted to nitrite which is then converted to ammonia and protein for animal use. However, when high levels of nitrate are consumed the system is altered (see Figure 2). Nitrate is rapidly converted to nitrite in the rumen, but ammonia conversion is typically slow. This allows nitrites to accumulate and pass into the bloodstream through the rumen wall. Once in the bloodstream, nitrites react with hemoglobin and prevent blood from carrying oxygen. This causes animals to "suffocate" because oxygen cannot be transferred from the lungs to the bloodstream. This is why animals that die from nitrate poisoning have labored breathing before death and chocolate-brown colored blood. The blood is dark colored because it cannot pick up oxygen. Membranes around the eyes and mouth are also a blue or purple color because of oxygen deficiency.

Figure 2. Nitrate toxicity in ruminants.



Management tools to avoid nitrate toxicity

Now that we know how nitrates are formed and why they affect cattle, logical management options can be discussed. The easiest method to prevent nitrate toxicity is to prevent plants from accumulating nitrates. This, of course, is usually not possible. In some cases irrigation can be used to prevent drought stress and nitrogen can be applied in split applications to reduce nitrate accumulation. If dry weather has severely limited plant growth and it is possible to delay hay harvest or grazing, try to do so. It should be safe to graze or cut hay about 10-14 days following an ADEQUATE rain. An adequate rain is one that supplies enough water for good, sustained plant growth. This will allow time for nitrates to be converted to proteins in the plant.

Nitrate levels are always highest in the lower stem portions. Leaves and seedheads generally contain low levels of nitrates. Grazing plants a little lighter than normal will decrease nitrates intake, improve diet quality and increase plant regrowth rates. Cattle grazing lightly stocked pastures will generally select leaves and avoid stems. This does not mean that lightly stocked summer annual pastures will not cause nitrate toxicity! It does suggest that heavily stocked drought stressed summer annuals are more likely to cause nitrate toxicity.

Turning out animals on pasture when they are full is also a wise management practice.

Once nitrates have accumulated in plants they can only be reduced by being converted into proteins. This can occur by plants "growing out" of high nitrate concentrations or through bacterial conversion in the rumen or silage pit. Generally, beef cattle can handle nitrate concentrations of 5000 ppm in hay. Animals can adapt to higher nitrate concentrations over long periods of time, but this can be risky. Supplementing energy concentrates increase the rate nitrites are converted into proteins in cattle and help offset high nitrate levels. Supplements containing urea or ammonia (i.e. poultry litter) should be avoided. Ensiling can reduce nitrates in forage by up to 60% due to bacterial conversion. Unfortunately, nitrates do not decrease in stored hay.

There is no substitute for forage testing to determine if dangerous levels of nitrates are present. Nitrate levels can vary within a field, so be sure to sample an adequate number of bales or plants for accurate testing. If one area of a field appears particularly drought stressed, store and sample hay from that area separately until nitrate levels are determined. Most county agents have hay probes and field nitrate test kits to determine nitrate levels in grazed forages and hay.

Conclusion

Hopefully these diagrams and tips are helpful for understanding, predicting and managing nitrate toxicity. Nitrate problems can be avoided if producers are aware of factors that cause buildup and how animals process nitrites. Summer annuals can be a productive and valuable addition to beef programs and, with a little management, provide safe and high quality forage.