

PREVENT A DROUGHT YEAR FROM BEING WORSE: TEST FOR NITRATES

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What's worse than a drought? It would seem that there's not much worse than trying to scrape together enough pasture, hay, or supplements to carry cows through a prolonged drought. But there is at least one problem that is a lot worse: poisoned cows.

Stressful growing conditions often result in high concentrations of toxic compounds in plant tissue. When forages containing toxic levels of these compounds are fed to an animal, poor productivity or even death may occur. The late frost and prolonged drought that we had this year may have set up the "perfect storm" with respect to at least one of these toxic compounds: nitrates.

The Effects of High Nitrates in the Animal Diet

Nitrate (NO_3^-) is reduced to nitrite (NO_2^{2-}) by microbes in the digestive tract of cattle and other animals. In most cases, the microbes further convert the nitrite to ammonia and ultimately to amino acids and proteins. However, nitrite levels build up when high concentrations of nitrates are ingested and the nitrite is absorbed into the animal's bloodstream. Once in the bloodstream, nitrites bind with hemoglobin (creating methemoglobin) and prevent the normal transfer of oxygen. Depending upon the amounts consumed, symptoms of nitrate poisoning may be hardly noticeable (Table 1). Relatively low nitrate intake levels (2500 - 5000 ppm) often result in lower milk production, abortion, breeding problems, or symptoms that mimic a nutritional deficiency (Vitamin A and E, rickets, phosphorus, or calcium imbalance).

Table 1. Management of various nitrate levels in animal rations.

Forage Nitrate (ppm* NO_3 in dry forage)	Management
0 – 2,500	Feed as part of a normal, well-balanced ration.
2,500 – 5,000	Safe to include in rations, though if animals are lactating or gestating the forage should be less than 50% of the ration.
5,000 – 9,000	Limit inclusion in the ration to less than 50% for growing animals and less than 25% in rations for lactating or gestating animals.
over 9,000	Dilute very carefully or exclude from rations to avoid the risk of the ingestion of a lethal dose.

* ppm = parts per million.

However, when nitrates are high (> 5000 ppm) the symptoms may be much more tragic. Symptoms of severe nitrate toxicity include bluish color of mucous membranes, rapid and difficult breathing, rapid pulse (≥ 150 beats/minute), tremors, staggering, collapse, and death. A key diagnostic feature of nitrate toxicity is dark brown or "chocolate-colored" blood. Unfortunately, by the time these

symptoms are noticed, it may be too late since acute toxicity may appear suddenly (often within one to two hours of ingesting toxic nitrate levels). This leaves little or no time for afflicted animals to be treated. Thus, prevention is the primary way to combat nitrate toxicity.

Nitrate Accumulation in the Plant

Plants take up nitrogen primarily in the form of nitrate. Depending on growth conditions, nitrates are often taken up in large quantities when the plant is vegetative and actively growing. However, nitrates may remain high when plants are subjected to conditions that substantially slow growth, such as during a drought, frost, or when cloudy weather slows the rate of photosynthesis. As a result, plants in vegetative stages are most likely to have high nitrate levels. Similarly, nitrates are more highly concentrated in stems and leaves that are closer to the soil surface.

This year, producers baled up a lot of freeze- and/or drought-damaged small grains (wheat, rye, oats, and triticale). The combination of these major weather events has led to high nitrate concentrations in many small grain hay lots. Randy Franks, County Extension Agent in Wayne County, recently asked me to take a closer look at this issue after we discussed some troubling small grain samples that he had observed. I looked at the analyses from the 57 small grain forage samples that came through UGA's Agricultural & Environmental Services Laboratory (AESL) during April. In general, these samples were, on average, safe for all classes of cattle (< 2500 ppm). However, I was troubled by the rather large range in nitrate toxicity levels of these samples (225 - 7488 ppm). As I looked at the samples in more detail, it was clear that nearly 25% of the samples were above the threshold of 5000 ppm.

These numbers represent only the forages that were analyzed. What is concerning to me is that there is (no doubt) tons of small grain forage that is at least this high (or higher) in nitrates that has not and will not be tested. Unfortunately, too many cattle producers will feed such forage, perhaps not knowing about this problem until it is too late. The tragedy of this is that nitrate toxicity can be prevented if a ration is balanced around high nitrate levels.

Prevention of Nitrate Toxicity

To prevent nitrate toxicity, producers should test several representative samples from any forage that is suspected to be high in nitrates. It is not uncommon for a portion of some forage lots to be very high in nitrates, while other portions are safe. A major cause of this variation is variability within a field (i.e., droughty soils and zones with higher weed pressures will commonly have the highest nitrate levels). Thus, it is best to test the forage prior to harvest whenever possible. This is important for two reasons. First, it gives as much time as possible for accurate results to be received from a laboratory analysis. Second, suspected "hot spots" can be identified within the field and sampled accordingly. Forage from these "hot spots" may be hidden within the lot during harvest and may or may not be represented if the hay lot or silage is sampled prior to feeding. It may only take one bale from a "hot-spot" to cause major problems.

If the laboratory analysis indicates moderate to high levels of nitrate (> 2,500 ppm), the forage can still be fed to most animals if it is managed properly. One management option is to dilute the nitrate concentration by blending the high nitrate forage with feedstuffs that are low in nitrates. In many

cases, growing animals (non-lactating, non-gestating) may become acclimated to higher nitrate levels by slowly increasing the proportion of higher nitrate feed. However, producers should minimize or avoid feeding forages that are high in nitrates to animals that are lactating, pregnant, or sick.

Supplementation with grain, grain by-products, and other feedstuffs that are high in energy may aid the conversion of nitrite to ammonia and reduce the risk of nitrate toxicity. Vitamin and mineral supplementation may also help to counter subclinical toxicity symptoms. Keeping plenty of clean water available to the animal will also help to dilute nitrate concentrations.

A checklist containing these and other suggestions to help reduce your risk of nitrate toxicity is provided below. To learn more about the potential dangers of nitrate toxicity, visit our website at www.georgiaforages.com or contact your local University of Georgia Cooperative Extension Service office.

Reduce the Risk of Nitrate Toxicity: A Checklist

- ✓ Identify all forage sources that have been subjected to conditions (e.g., drought- and/or freeze-damage) that may have caused high nitrate levels.
- ✓ Test all suspect forages for high nitrates.
- ✓ When possible, collect representative samples from areas within fields that are most likely to be high in nitrates (e.g., droughty soils, zones with higher weed pressures, etc.) prior to harvest.
- ✓ Pay particular attention to those forages that have been fertilized heavily with nitrogen or are crop species that tend to accumulate nitrates (sorghum/sudangrass, pearl millet, johnsongrass, corn, small grains, etc.).
- ✓ Split applications of nitrogen fertilizer (organic or inorganic) within the growing season.
- ✓ Prevent forage harvests within 7 days following a drought-ending rain.
- ✓ Do not feed green chop until the nitrate concentration in the whole plant is known.
- ✓ Harvest the crop as silage when possible, since nitrates decrease during fermentation.
- ✓ Increase the harvest height to minimize the inclusion of elevated nitrate concentrations in the lower parts of the plant stem and any low growing weeds.
- ✓ Do not overgraze the crop so that the animals graze the leaves and more tender top portions of the stalk rather than being forced to eat the lower stalk where nitrate levels are highest.
- ✓ Dilute forages that are high in nitrate with feedstuffs that are low in nitrate and high in energy.
- ✓ Avoid or minimize the use of forages that are high in nitrates to feed cattle that are lactating, pregnant, or sick.
- ✓ Provide plenty of clean water and supplement with sufficient vitamins and minerals.