



# Nitrate and Prussic Acid Poisoning

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**N**itrate and prussic acid poisoning in cattle are noninfectious conditions that can kill livestock. Although uncommon in normal years, these poisonings occur when cattle eat forages stressed

from severe environmental conditions such as drought. The stress disrupts normal plant growth and may cause the plants to accumulate too much nitrate or prussic acid.

Although the growing conditions causing them are similar, the diseases differ greatly. Knowing the causes, symptoms and treatments for these diseases can help producers prevent losses. Sampling and testing can indicate when forages pose a danger to livestock.

## Nitrate poisoning

Nitrate is present to some degree in all forages, and technically, nitrate poisoning is better described as nitrite poisoning. When livestock consume forages, nitrate is normally converted in the rumen from:

**nitrate to nitrite to ammonia to amino acid to protein.**

When forages have an unusually high concentration of nitrate, the animal cannot complete the conversion and nitrite accumulates. Nitrite is absorbed into the bloodstream directly through the rumen wall and converts hemoglobin (the oxygen-carrying molecule) in the blood to methemoglobin, which cannot carry oxygen. The blood turns a chocolate brown color rather than the usual bright red. An animal dying from nitrate (nitrite) poisoning actually dies from asphyxiation, or a lack of oxygen.

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Nitrate poisoning usually does not occur rapidly, but over time, depending on how high the nitrate level in the forage.

## Causes

Nitrate poisoning can occur when:

- Forage consumed contains high levels of nitrate;
- The diet changes rapidly or suddenly;
- Parasitism or other conditions causing anemia;
- Livestock consume supplements of urea or high-protein feeds along with forage containing moderate levels of nitrate; and/or
- Livestock directly consume nitrite.

## Symptoms

Acute nitrate toxicity symptoms generally include death, blue mucous membranes (lack of oxygen), fast breathing, high pulse rate, weakness, uneasiness, excessive salivation, frequent urination and dilated and bloodshot eyes. Animals treated with methylene blue may recover. But by the time an animal “goes down,” it is often too late to treat and rescue. A veterinarian should be called to verify the cause of death.

## Nitrate accumulations

Plants need nitrogen for growth and development. However, when drought prevents them from converting the nitrogen they absorb into new growth, nitrate levels may rise.

Many kinds of plants can accumulate nitrate. Plants in the sorghum family — Johnson grass,

sudan grass, forage sorghum and sorghum hybrids — are generally implicated first. “Oat-hay” poisoning is caused by high nitrate levels. Corn, small grains, carelessnessweed or pigweed, sunflower and leafy vegetables that are highly fertilized can accumulate toxic levels. Turning cattle into holding pens or corrals full of manure with carelessnessweeds or grasses can result in immediate poisoning.

Nitrates do not accumulate when there is normal rainfall or irrigation. Under those conditions, nitrate nitrogen absorbed by roots and moved into the plant is rapidly transformed into plant proteins.

However, under dry conditions, plant roots continue to absorb small amounts of nitrogen, but the plant has too little water to keep growing. Nitrate accumulates and is stored in lower leaves and stems, ready for the plant to mobilize and use when rapid growth resumes.

Nitrate levels can change from day to day and even from morning until evening. Small grains can accumulate toxic levels of nitrate on overcast days. In cloudy periods, plants continue to absorb nitrogen from the soil but lack the photosynthetic activity to convert the nitrogen into proteins.

### Preventing losses

Producers can take steps to help prevent nitrate poisoning:

- Never turn hungry animals into possibly high nitrate forages. During drought, producers sometimes “turn onto” temporary forages to help animals in poor condition. The combination of poor body condition, high nitrate levels in the forage and high consumption can be deadly.
- Turning one old cow into a new field to observe is not an effective test for nitrates, because cattle tend to bite the tops of plants first, where the concentration is lowest. As cattle are forced to eat the lower plant parts, poisoning could occur later when it is not suspected.
- Have hay tested before feeding if you suspect that it is high in nitrate. Nitrate levels remain constant in hay.
- If hay is high in nitrate, feed carefully with an energy supplement or in combination with low-protein forages, or other hay low in nitrates. Never feed high-nitrate hay free choice.

- Ensilage forages high in nitrate. When hay is properly fermented, nitrate levels are reduced by 40 to 60 percent. However, be careful in enclosed areas. High-nitrate forages can produce nitrogen dioxide (silo gas), which is very poisonous to humans.

Other factors to consider:

- Irrigation or rain renews plant growth, which will lower nitrate levels (however, this could lead to prussic acid poisoning in sorghums as discussed below).
- Green chopping is the most dangerous feeding method.
- Cattle can adapt to higher than normal levels of nitrates if the increase occurs slowly. Healthy animals are less likely to develop problems than those that are weak or sickly. Also, if enough carbohydrates are supplied, the digestive system can convert the nitrogen into ammonia or proteins faster, making it less likely that dangerous levels of nitrite accumulate.

### Toxicity guidelines

The Texas Veterinary Medical Diagnostic Laboratory advises that, in general, all ruminants can safely eat forages that contain up to 1 percent nitrates on a dry weight basis. Monogastrics (horses, mules and pigs) are less sensitive to nitrate intoxication.

### Prussic acid poisoning

Prussic acid poisoning is one of the most toxic and rapidly acting of any common poison. It is also called hydrocyanic acid or cyanide poisoning. Cyogenic compounds can develop in plants that are stressed; in the rumen the compounds are converted to cyanide, which can kill livestock.

### Symptoms

Livestock can show symptoms of intoxication within 5 minutes of eating plants with the poison, and may die within 15 minutes. Salivation and labored breathing occur first, followed by muscular tremors, uncoordinated movements, bloating, convulsions and death from respiratory failure.

### Prussic acid accumulations

Although there is usually little danger of prussic acid poisoning, it can accumulate in plants in the sorghum family, such as Johnson grass, sudan

Table 1. Comparisons of nitrate and prussic acid.

Conditions	Nitrate	Prussic acid
Plant parts affected	Older lower leaves	Young growth, new growth
Types of plants	All plants, especially sorghum and careless (pigweed)	Sorghums, plum thickets, etc.
Grazing problems	Occur when animals eat lower plant parts	Occur early in the grazing period
Death occurs	Usually within 4 hours of consumption	Within minutes of consumption
Affect of haying on concentration	None - concentration stays the same	Dissipates when properly cured

grass, forage sorghums and grain sorghum. It is also found in bahia, corn, cocklebur, white clover and other minor plants, but seldom at toxic levels.

One problem with prussic acid is that it tends to “come and go” in the plant: It may be present for a short time and then dissipate. It appears to occur when plants are injured by herbicides or frost. Severe drought stress can also cause prussic acid to form.

High concentrations of prussic acid may be associated with rapid cell division or rapid growth, such as shortly after a rain or irrigation on previously drought-stressed fields, or warm weather after a cool period. Under good conditions, toxic concentrations can also form in young, rapidly growing plants.

On the positive side, prussic acid dissipates from plants properly cured for hay. However, in hay baled early at high moisture or plants chopped for immediate feeding, the prussic acid may not have had a chance to dissipate.

### Preventing losses

To prevent prussic acid poisoning:

- Do not graze any of the cyanogenic-accumulating plants (sorghums) that have been subject to drought or injury, unless they are tested for hydrocyanic acid.
- If plants have been damaged by herbicides or frost, defer grazing until they either are well recovered from injury or cut for hay, or after a killing freeze and the plants have been allowed to dry.
- Do not graze plants in the sorghum family until they are 2 to 3 feet tall.
- Graze second-growth sorghums with caution if growing conditions are poor.
- Remove all livestock from the feed source when an animal is found to have died suddenly after grazing forages under poor growing conditions.
- Prevent animals from grazing wilted plants or those with young tillers.
- After plants have grown rapidly, such as shortly after a rain or irrigation on previously drought-

stressed fields, or warm weather after a cool period, wait at least 2 weeks after the plants begin to grow before grazing.

## Sampling and testing

Forages can be tested for both nitrate and prussic acid either as standing forage or as hay.

**Nitrate testing:** Evaluate the pasture or field in question as a single unit, and take samples representing all the variations of forage growth. For example, collect a few stalks from high spots, a few from low spots, a few of the tallest and a few of the shortest plants. If the pasture is level, think of it as a grid of 12 boxes and collect one stalk from each box. A good sample for nitrate testing consists of 12 to 15 plant stalks with leaf material. Cut the stalks about 3 inches above the ground; any pulled up by the roots will contaminate the sample with soil and give a false analysis.

Collect hay with a hay probe. Get a representative sample by combining material from several bales.

**Prussic acid testing:** Cyanide begins to leave the sample as soon as the plant begins to die. Therefore, it is critical that producers hand-carry or ship overnight all samples to be tested for prussic acid.

The plant sampling method is similar to that for nitrate. A good sample for prussic acid testing consists of leaves from 10 to 12 plants. Refrigerate but do not freeze the samples in transit to the lab.

Sampling and handling baled hay presents severe problems, because prussic acid is lost rapidly after the bale is opened. Use a hay probe, empty the sample immediately into a pint canning jar (only one probe per sample jar), seal the jar and send it to the lab overnight.

Plant samples may be sent to the Texas Veterinary Medical Diagnostic Laboratory (TVMDL), P.O. Drawer 3040, College Station, Texas 77841-3040. If using an overnight carrier, the street address is TVMDL, 1 Sippel Road, College Station, Texas 77843. Phone: (409) 845-3414.

Results are generated on the day the sample is received for prussic acid and the next day for most nitrate assays.

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