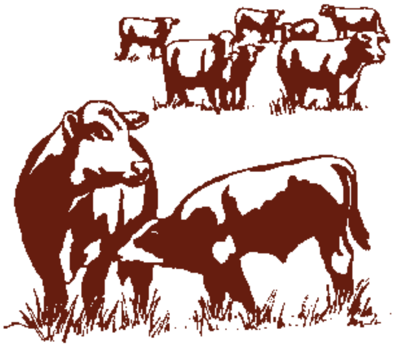
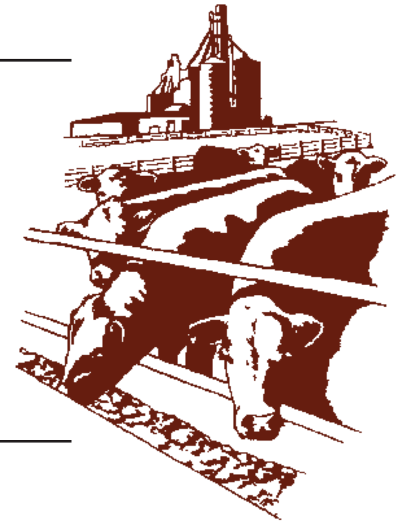


Beef Cattle Handbook



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Nitrate Poisoning in Livestock

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Nitrate poisoning is a noninfectious disease condition that affects domestic ruminants (National Academy of Sciences 1972). All species consuming forages or drinking water containing toxic levels of nitrates can be affected. Cattle are the most common victims. Livestock allowed access to farm chemicals with a nitrate content can also die of nitrate poisoning.

Nitrate poisoning is not a new problem (Cowley and Collings 1977; Hibbs 1979; National Academy of Sciences 1972; Osweiler et al. 1985). It has been reported throughout the United States with a wide variety of feedstuffs. This fact sheet will outline the disease and how to manage and prevent the problem.

Plant Nitrates

Abnormal accumulation of nitrate in plants is influenced by several factors. The most important of these are the following (Osweiler et al. 1985):

1. Species of plants.
2. Content and form of nitrogen in the soil. Soils high in nitrate content or ammonia levels supply nitrate more readily to plants.
3. Soil conditions that favor nitrate uptake: adequate moisture for uptake; acid soils favor nitrate absorp tion; low molybdenum; sulfur deficiency; phosphorus deficiency; low temperature (55^{o}F); soil aeration.
4. Drought conditions.
5. Low light conditions. Light is required to maintain the activity of the enzyme nitrate reductase, which is necessary to prevent the accumulation of nitrate.
6. Herbicide treatment with phenoxyacetic herbicides that promote rapid plant growth. Nitrate concentration tends to be highest 3 to 5 days after herbicide application.

Nitrates accumulate in vegetative tissue, not in fruits or grain. Accumulation of nitrates is usually greater in the stalk than in the leaves.

Understanding Nitrate Toxicity

Nitrates normally occur in plants and are a necessary soil nutrient for crop growth. Nitrate that is ingested by cattle is converted to nitrite (nitrition is about 10 times more toxic to the animal than the nitration) and then to ammonia by ruminal bacteria (Cowley and Collings 1977; Emerick 1974). Ammonia is a protein-building chemical. If excess nitrates are ingested, excess nitrites accumulate in the rumen because the bacteria are unable to convert all the nitrite into ammonia. Nitrite is absorbed into the oxygen transporting chemical hemoglobin. The blood can no longer transport oxygen to the body tissues and the animal's heart rate increases, the normal pink tissue color changes to blue, muscle tremors develop, the animal staggers, falls to the ground, and dies (Cowley and Collings 1977; Emerick 1974; Hibbs et al. 1978).

Many publications report that consumption of nitrates at levels above normal, but below toxic stage, can cause lower milk production, reduced weight gains, and vitamin A deficiency. It also can increase the incidence of stillborn calves, abortions, retained placenta, and cystic ovaries (Hibbs et al. 1978; Johnson et al. 1983; Osweiler et al. 1985). In one New Mexico case where nitrate toxicosis was reported, 226 head of cattle were lost from a herd of 390 head, and 42 cows aborted. Abortions started 48 hours after the exposure and continued for 3 weeks. In another case, 22 out of 242 cows were lost. Nine abortions occurred from 96 hours to 7 days after exposure. These symptoms may be subtle and have been difficult to reproduce experimentally.

Cattle can tolerate a wide range of nitrates (Cowley and Collings 1977; National Academy of Sciences 1972; Osweiler et al. 1985). The potential for a toxic reaction is increased if the general health of the cattle is poor, or if a sudden dietary change introduces the suspect forage. Anemic cattle, commonly due to lice or stomach worm infestations, are more likely to be affected by nitrate poisoning.

Diagnosis of nitrate poisoning is difficult. Producers should be suspicious of nitrate poisoning if the diet includes crops prone to nitrate accumulation. Grazing of fields with such crops or fields infested with nitrateaccumulating weeds should be avoided. Animals dying from nitrate poisoning will undergo rapid postmortem changes suggestive of ruminal bloat. A postmortem examination by a veterinarian is necessary to determine the cause of eath. Testing forage and drinking water before there is trouble is advised. Cattle should not have access to farm chemicals.

Management Practices to Minimize Nitrate Poisoning

Do not feed known nitrate-accumulating forages (i.e., sudan, sorghum, or oat hay) without a chemical analysis. Follow proper sampling procedures when collecting forage samples. Also, an analysis of water supplies is recommended so that adjustments to the feeding program can take into account the water nitrate contribution. Feeds being used to dilute nitrate hay should also be analyzed.

Consider making silage out of high-nitrate forages. The ensiling process will reduce nitrate levels by approximately 40 to 60 percent. However, forages cut for silage can be as high as 2 to 5 percent potassium nitrate (KNO^3). Even if nitrate is reduced by half, toxicity may be a problem. It is suggested that silages be tested for nitrates before they are fed to livestock.

Change rations gradually, over a 7 to 10 day period, especially when new feed is known or suspected to contain nitrates. Ruminants have the ability to adapt to gradually increasing nitrate levels, up to a point. Too rapid change in the diet can trigger nitrate poisoning.

Dilute high-nitrate feeds with feeds lower in nitrate. A balanced, high energy ration will help ruminants. Grain feeding seems to be helpful in addition to its effect in diluting the nitrate content of the feed. Energy from the grain apparently helps to complete the conversion of nitrate to ammonia, which is then used by the ruminal bacteria.

If grazing pasture with suspected elevated nitrate levels, graze only a couple of animals the first week. If problems do not arise, put the rest of livestock on pasture. Nitrates are less of a problem if pasture forages are not actively growing.

Frequent intake of small amounts of a high-nitrate feed increases the total amount of nitrate that can be consumed daily without toxic effects. More of a high nitrate forage can be fed without harmful effects by feeding it in limited amounts several times daily rather than feeding large amounts once or twice daily. When nitrate is fed continuously, animals become adapted to higher nitrate concentrations and may be able to use a portion of dietary nitrate as nonprotein nitrogen.

Do not use damp feed for livestock. Dampness tends to heighten toxicity. The probable explanation is that some of the nitrate is converted by bacterial denitrification to nitrite before animal consumption.

Herd health is an important consideration. Healthy animals are less affected than animals in poor health. Parasitism or other conditions causing anemia will increase susceptibility.

Nitrate toxicity does not appear to be altered and is not enhanced by simultaneous feeding of urea.

Table 1. Level of Potassium Nitrate (KNO3) in Feed and Animal Response.

% KNO3 in Feed	Comment or Animal Response
0.0 to 0.44	Safe to feed. Use caution with pregnant or young animals at the upper level.
0.45 to 0.88	Generally safe when fed with balanced ration. For pregnant animals limit nitrate feed to 1/2 of daily dry matter intake.
0.89 to 1.50	Limit to 1/4 of the total daily ration. Ration should be well fortified with energy, minerals, and vitamins.
over 1.5	Toxic. Extreme caution should be used. A well-mixed feed, below a 1 inch chop, or pelleting the feed will reduce sorting by animals. Amount of dilution with other feeds depends on nitrate level.

Formulas for Converting Methods of Reporting

potassium nitrate = nitrate x 1.6
potassium nitrate = nitrate nitrogen x 7.0
nitrate = potassium nitrate x 0.6
nitrate = nitrate nitrogen x 4.4
nitrate nitrogen = potassium nitrate x 0. 14
nitrate nitrogen = nitrate x 0.23
parts per million = percent x 10,000
percent = parts per million /10,000

Table 2. Water Potassium Nitrate (KNO3) Level in Relation to Nitrate Toxicity.

KNO3 in Water (ppm)[1]	Comment
0 to 69	Safe
70 to 209	Doubtful
210 to 349	Risky, subclinical toxicity
350 to 699	Do not use, subclinical toxicity
700 to 1,050	Do not use, sublethal but toxic
over 1,050	Do not use, acute toxicity and lethal

[1] *ppm = parts per million*

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