Nitrate Toxicity in Drought-Stressed Forage Crops

Hot and dry growing conditions can result in drought-stressed crops. Knowing how nitrate nitrogen accumulates in forage crops, how eating those forages affects dairy cows, and what can be done to reduce the challenges of drought-stressed forages can help producers weather less-than-ideal growing conditions.

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We have all just experienced a very hot and dry Michigan summer. Due to the summer weather, there may be concerns about nitrate toxicity in drought-stressed forage crops. The following information will be helpful in understanding: 1) how nitrate nitrogen is accumulated in forage crops; 2) how nitrate toxicity causes problems in ruminants; 3) what clinical signs we see from acute nitrate toxicity; 4) what available treatment options are; 5) how to reduce the potential nitrate toxicity; and, 6) how to interpret nitrate test results.

1 Nitrate Accumulation in Forage Crops. Nitrate nitrogen (NO₃-N) is one of the inorganic nitrogen forms used by forage crops and converted to protein by plant cells under normal environmental conditions. The following factors tend to increase nitrate accumulation: 1) forage species (corn, sudangrass, sorghum, pearl millet, and oats); 2) lower portions of the plant; 3) higher rate of nitrogen from fertilizer or manure; and, 4) drought-stunted plant growth, resulting in nitrate accumulation.

2 Mechanisms of Nitrate Toxicity in Ruminants. Rumen microbes convert nitrate (NO₃) into nitrite (NO₂) and in most cases, the rumen microorganisms further convert the nitrite to ammonia and ultimately to amino acids and protein. However, if the rate of conversion of nitrate to nitrite is greater than the conversion of nitrite to ammonia, the excess nitrite in the rumen is absorbed into the blood stream. The nitrite can decrease oxygen-carrying capacity of the blood.

3 Clinical Signs of Acute Nitrate Toxicity. Signs of acute nitrate toxicity result from severe blocking of oxygen transfer to cells and the typical symptoms of acute nitrate toxicity are: 1) rapid and difficult breathing; 2) brownish to bluish color to normally pink tissue of the mouth, nose, or vulva; 3) dark brown or chocolate-colored blood; 4) excessive salivation, grinding teeth, and unsteady gait; 5) collapsing, coma and death; and, 6) abortions.

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Treatment Options for Acute Nitrate Toxicity. Acute nitrate toxicity may occur suddenly, within one to two hours of ingesting feeds with toxic levels. With so little time to treat toxicity symptoms, prevention is the most important way to minimize the nitrate toxicity occurrence. If brownish coloration of blood or tissues is noticed, immediately call a veterinarian. Methylene blue can be administered as a treatment.

Ways to Reduce the Nitrate Toxicity.

Fertilization: Because nitrogen fertilization is directly related to nitrate toxicity, it is important to apply nitrogen fertilizer in increments throughout the growing season rather than applying the full rate at the beginning of the season. Pre-Sidedress Nitrate Test (PSNT) when corn reaches a height of 12 inches may help reduce the nitrate toxicity by determining the nitrogen requirement of the corn. Also, balancing other nutrients in the soil such as phosphorus and potassium may reduce the nitrate toxicity problems.

Harvest Management: Nitrate accumulates mainly in corn, sudangrass, sorghum, pearl millet, and small grains. Ensiling will reduce the nitrate content of the silage because the bacteria in the ensiling process utilize the nitrate. It is not recommended to green chop forages that are suspected to contain high nitrate levels.

Feeding Management: It is recommended to test the nitrate level before feeding silage made from drought-stressed corn or other forages. Most feed testing laboratories test feeds for nitrates. It is important to take representative samples, keep the samples refrigerated, and send them to the lab as quickly as possible (do not send the samples on Thursday or Friday). Labs that can be contacted include: MSU Soil and Plant Nutrient Lab (517-355-0218), Litchfield Analytical Services (517-542-2915), AgSource (715-758-2178), Dairyland Laboratory (608-323-2123), and Marshfield Plant and Soil Analysis Laboratory (715-387-2523).

Interpreting Nitrate Test Results

If nitrate content of feed is reported on an “as-is” basis, convert to 100% dry matter basis. For example, silage at 50% moisture that contains 600 ppm NO₃-N on an “as-is” basis contains 1200 ppm on 100% dry basis.

Table 1 lists general feeding recommendations based on nitrate concentrations in the forages.

| Nitrate Concentration in a Feed Ingredient and Feeding Recommendations. |
|---------------------------------|-----------------|-----------------|-----------------|
| NO₃ ppm | NO₃-N ppm | Feeding Recommendations |
| <4,400 | <0.44 | Safe to feed, non-toxic level |
| 4,400-8,800 | 0.44-0.88 | 1,000-2,000 | 0.2-0.4 | Limit the feed to less than 50% of ration dry matter |
| 8,800-17,600 | 0.88-1.76 | 2,000-4,000 | 0.2-0.4 | Limit the feed to less than 25% of ration dry matter, do not feed to pregnant cattle |
| >17,600 | >1.76 | >4,000 | >0.4 | Do not feed |