Frequently Asked Questions - Forage Nitrate Toxicity in Ruminant Livestock

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Forages play an important role in ruminant diets, but some forages can contain toxins that can be detrimental to livestock. This Frequently Asked Questions Fact Sheet will address nitrates (NO_3).

1. Why should I be concerned about nitrate levels in forages?

When forage with high nitrates is fed to livestock, the nitrate is reduced to nitrite. If this happens too fast, the nitrite is absorbed into the blood stream and does not allow blood to transport oxygen to body tissues, which can result in abortion and death. Death usually occurs within 3 to 4 hours of symptom onset. The blood will be chocolate brown in color.

2. What feeds are most likely to accumulate nitrates?

Nearly all plants contain some level of nitrate at certain time points throughout the growing season. However, certain forages and common weeds are higher risk for nitrate accumulation. Table 1 contains the plants with the highest potential to accumulate nitrates.

3. Are there certain conditions that increase the risk for elevated nitrate levels in forages?

Yes, stressed plants can have elevated nitrate levels. Such stressors can include excess soil nitrates or factors that interfere with normal plant growth, such as drought.

Nitrogen fertilization and drought conditions are the most important factors contributing to nitrate buildup in plants. Generally, plant nitrate level increases in direct response to nitrogen fertilizer. Under unfavorable growing conditions, especially drought, the conversion of nitrate into amino acids is retarded, causing the nitrate to accumulate in the stalks, stems, and other conductive tissue. If moisture conditions improve, the conversion process accelerates, and within a few days nitrate levels in the plant return to normal.

Table 1. Grasses and forbs with high potential for nitrate accumulation

High Potential for Nitrate Accumulation	
Grasses	**Forbs**
Small grains (oats, barley, wheat, rye)	Kochia
Corn	Lambsquarter
Sudangrass	Morning glory
Sorghum	Red root pigweed
Millet	Puncture vine
Bromegrass	Russian thistle
Orchardgrass	Sunflower
Fescue	Horse nettle
Johnsongrass	Ragweed

4. How and where can I get my forages tested?

Nitrate QuikTest for Standing Forages: This qualitative test provides a positive or negative result and can be used to determine safety of haying or grazing a forage crop. This test is sensitive and can detect low levels of nitrate. More information about testing locations is available here https://extension.sdstate.edu/nitrate-quiktest-forages.

Laboratory Analysis: If the forage has been harvested or QuikTest results are positive and a quantitative value is needed, representative samples can be sent to a commercial laboratory for analysis. A partial list of commercial laboratories can be found in the Feed & Water Testing Laboratories [https://extension.sdstate.edu/sites/default/files/2020-05/MC-00901.pdf] Fact Sheet. Check the "Services" section of the lab, to ensure they test for nitrates.

5. What do my results mean?

Nitrate QuikTest: Blue = Positive, Clear = Negative, Red or brown = Negative, solution is reacting with the sugars, not nitrates.

Laboratory Analysis: Determine the form and unit of measure on the analysis (nitrate (NO_3), nitrate nitrogen (NO_3-N) or potassium nitrate (KNO_3)). Utilize Table 2 to interpret laboratory results and determine how feed can be incorporated into rations livestock.

6. What options do I have to use feed that has elevated nitrate levels?

Silage: Ensiling forage can reduce nitrates by as much as 50%, if all factors are correct, including moisture at 60-68%, and proper packing density. Drought-stressed corn is often wetter than visual conditions might indicate, so accurate sampling and testing is critically important to avoid harvesting too early. Consider raising the cutting height to reduce the amount of nitrate in the feed. Following fermentation (3-4 weeks) send a sample to a lab to determine nitrate level prior to feeding.

Dilution: See Table 2 for recommendations on blending feeds. Careful mixing is critical to avoid abortion or death. Energy from grain, such as corn, can help complete the conversion of nitrate to ammonia, therefore decreasing the risk of nitrate toxicity.

Grazing: Nitrate is highest in the lowest 1/3 of the stalk, so do not force animals to graze that low. Leaves are a safer option. Once leaves are removed, move the livestock. Avoid turning hungry livestock onto a suspect field. Use caution when grazing suspect fields immediately after a rain as there may be an increase in nitrates under those conditions.

Table 2. Interpretation of laboratory results.

Form of Nitrate Measured (DM Basis)						Recommendations for use in livestock
Nitrate Nitrogen (NO_3-N)		Nitrate (NO_3)		Potassium Nitrate (KNO_3)		
ppm	%	ppm	%	ppm	%	
0-1,000	0-0.10	0-4,430	0-0.44	0-7,220	0-0.72	Safe to feed if adequate feed and water are available.
1,000-1,500	0.10-0.15	4,430-6,645	0.44-0.66	7,220-10,830	0.72-1.08	Safe for non-pregnant animals. Limit to 50% of ration for pregnant animals.
1,500-2,000	0.15-0.20	6,645-8,860	0.66-0.88	10,830-14,440	1.08-1.44	Limit to 50% of total ration dry matter for all animals.
2,000-3,500	0.20-0.35	8,860-15,505	0.88-1.55	14,440-25,270	1.44-2.52	Limit to 35 to 40% total ration dry matter. Do not feed to pregnant animals.
3,500-4,000	0.35-0.40	15,505-17,720	1.55-1.77	25,270-28,880	2.52-2.88	Limit to 25% total ration dry matter. Do not feed to pregnant animals.
>4,000	>0.40	>17,720	>1.77	>28,880	>2.88	Toxic. DO NOT FEED.

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