Nitrate and Sulfur in Fall Grazed Cover Crops

A.S. Leaflet R3312

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Summary and Implications

It is well known that annual grasses and brassicas utilized as cover crops can accumulate nitrate, and brassicas may accumulate sulfur. Most samples tested through this project would be considered safe for nitrate while about half tested high in sulfur. A link between forage nitrate and sulfur levels to manure application or soil fertility levels was not able to be identified in this study due to variability in fertility practices across farms sampled. Further research is needed to understand the impact of manure and soil fertility level on the nitrate and sulfur level in fall grazed cover crops.

Introduction

Incorporation of cover crops into Iowa farms has been a high priority to reduce erosion, reduce loss of nitrates into water, and improve soil health. In addition to agronomic benefits, cover crops provide an opportunity for Iowa cattlemen to add grazing days into their operation and reduce feed costs. Though considered a high quality feed, a risk when grazing cover crops is the potential for high levels of nitrate and sulfur to accumulate in the plant. With the addition of corn co-products into feed rations, soils that have had manure applied can have higher soil levels of both nitrogen and sulfur, which could lead to accumulation of nitrate and sulfur in plant tissue. In fall grazed cover crops, this may have negative impacts on cow health without management practices in place to mitigate the effects.

Materials and methods

To evaluate potential risk from nitrates and sulfur when grazing cover crops, an Iowa Beef Center mini-grant was used in the fall of 2017 to collect and analyze 20 additional cover crop samples from 8 cooperators. Samples were analyzed for nitrate and sulfur levels. Samples were cut at soil level. All samples were frozen and held until delivering to the ISU Veterinary Diagnostic lab for testing. Manure and fertilizer application records, and soil test analysis were collected when available.

Results and Discussion

Safe levels of nitrate and sulfur for beef cattle are difficult to determine. Nitrate is very mobile in the plant and changes based on soil nitrogen level, moisture, stress on the plant, and tends to concentrate in the lower part of plants. Many grass species have the potential to accumulate nitrate in drought or stressed growing conditions. Large intakes of nitrate at a single feeding increases the risk of nitrate toxicity compared to the same level over a period of several hours. Livestock also have the ability to adapt to high levels of nitrate intake over time. The inclusion of grain in the diet also reduces the risk of nitrate toxicity in ruminants.

Sulfur can also accumulate in cover crops, particularly turnips and radish. Sulfur tolerance varies in the ruminant based on the ration, with 0.3% considered the maximum tolerable level on diets with more than 85% concentrate, and 0.5% in diets with more than 40% forage. Rumen bacteria reduce sulfur to hydrogen sulfide (H_2S) which causes health issues when eructated and inhaled. Low rumen pH favors the formation of H_2S which increases levels in the rumen. Since high forage diets reduce the pH in the rumen, it also supports the tolerance of higher levels of sulfur in the diet.

The ISU Veterinary Diagnostic Lab assumes less than 6500 ppm nitrate as a safe level for cattle to consume (Ensley, 2012). Only one of the samples was near this upper limit for nitrates. That field had one ton of chicken litter applied the prior fall, and the cover crop was turnips with only the tops sampled.

Fifteen of the samples were at or above the 0.4% level considered safe for sulfur. Of those, 8 had manure applied, 3 applied commercial fertilizer in the fall but no manure and 4 reported no manure or fertilizer applied after grain harvest.

Sulfur levels of annual grasses were similar to those found by Lenz et al., 2018 (0.30% for oats), but brassica levels were much lower in this study (0.69-1.04% S).

One cooperator sampled forage species separately on three fields. These species included spring wheat, turnip tops and turnip roots. One field did not have soil test results available, but the other two were very high in P_2O_5 and K_2O due to long-term manure application. Manure application on all three fields exceeded nutrient removal for a 200 bushel (dry corn equivalent) corn silage yield. All samples were safe by ISU Veterinary Diagnostic Lab standards for nitrates. For sulfur, 2 of the 3 turnip tops, and all three of the turnip root samples were at or above the safe level of 0.4% S.

Testing for cover crop levels of nitrate and sulfur indicate plant species and fields where caution is needed in managing grazing animals, but may not provide a definitive answer about forage safety. Dilution with other feeds and high forage diets are two methods to manage potential toxicity.

Table 1. Dry matter, nitrate and sulfur level of samples collected.

Sample ID	Forage Type	DM, %	Nitrate (NO_3) DM (ppm)	% Sulfur DM Basis
4	brassica	15	860	**0.5%**
5	brassica	9	1411	**0.4%**
6	brassica	15	727	0.2%
7	brassica	9	1767	**0.5%**
8	brassica	14	714	**0.6%**
9	brassica	10	1000	**0.4%**
10	brassica	20	670	**0.5%**
11	brassica	36	278	0.3%
13	brassica	27	370	**0.4%**
15	brassica	19	526	**0.6%**
16	brassica	43	2460	**1.1%**
17	brassica	32	**6345**	**0.9%**
18	brassica	9	2724	**0.5%**
20	brassica	11	909	**0.5%**
1	grass	22	455	0.3%
2	grass	26	385	0.3%
3	grass	23	435	0.2%
12	grass	22	455	0.3%
14	grass	27	370	**0.8%**
19	grass	33	2445	**0.5%**
21	mix	24	42	0.3%
22	mix	21	386	0.3%
23	mix	9	499	**0.4**%
Average		21	1140	0.47%
Avg. Brassicas (n = 14)		19	1483	0.54%
Avg. Grasses (n = 9)		23	608	0.37%

Table 2. Dry matter, nitrate, and sulfur level of individual species grown as a mix on three fields.

			Dry Basis	
Field	**Species Sampled**	**% DM**	**Nitrate (NO_3) (ppm)**	**% Sulfur**
1	Spring wheat	26	385	0.3%
1	Turnip bulbs	9	1767	**0.5%**
1	Turnip tops	15	727	0.2%
2	Spring wheat	22	455	0.3%
2	Turnip bulbs	9	1411	**0.4%**
2	Turnip tops	15	860	**0.5%**
3	Spring wheat	23	435	0.2%
3	Turnip bulbs	10	1000	**0.4%**
3	Turnip tops	14	714	**0.6%**

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