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Nitrate Poisoning--Causes and Effects

Merle Cunningham, Extension Dairyman and K. M. Weinland and S. J. Boyer, Extension Veterinarians

THE SITUATION IN INDIANA

Many Hoosier farmers are concerned about the potential dangers of nitrates in their forages. This concern arises from numerous reports from several Midwestern states in recent years and the various animal health problems on their own farms. These local problems often resemble the symptoms of nitrate poisoning. Many times they resemble symptoms of other factors, also.

To date, no cases of nitrate poisoning have been positively diagnosed as such at Purdue University. However, every livestock farmer should be aware of the possible causes and symptoms, as well as accepted methods of feeding high nitrate feeds if they should occur.

The possible effects of nitrates upon animals should not prevent the continued use of recommended fertilizer applications on Indiana farms.

CAUSE OF HIGH NITRATE IN FORAGE

Normally, plants convert nitrate from the soil into plant protein and amino acids. Under certain conditions this conversion is interrupted and nitrate accumulates in the plant. Several factors contribute to increased nitrate levels -- high levels of soil nitrate, environmental factors and differences in plants.

Nitrates may accumulate in the soil through decomposition of plant and animal materials and from the addition of commercial fertilizers. Also an imbalance of soil nutrients may be involved.

Environmental Effects

Drought conditions such as relatively low soil moisture, high environmental temperatures and low humidity contribute to increased nitrate accumulation. These factors may cause drying and firing of leaves and reduce the plant's ability to convert nitrate to protein. Some of the nitrates drawn into the plant build up in the stalk and leaves rather than into protein. This accumulation may increase after a rain when plant damage has already occurred. Other factors resulting in similar effects include hail damage, continued growth after frost, or spraying with herbicides.

Low light intensity caused by cloudy weather, shading and crowding of plants increase nitrate accumulation in plants because
energy from sunlight is needed to convert nitrates to plant protein.

**Variation between Plant Species and Variety**

The ability to convert nitrates to plant protein and amino acids varies with plant species and variety.

Annual forage crops such as corn, sorghum crops, sudan, rape and small grains apparently accumulate more nitrate than perennial crops such as most grasses and legumes.

Weeds known to accumulate nitrate include lamb’s quarter, bull nettle, jimson, Canada thistle, wild mustards, golden rod, boneset and rough pigweed.

**Variation within the Plant**

The concentration of nitrate is usually quite low in the grain of the mature plant, intermediate in the leaves and highest in the stem or stalk. Consequently, considerably less danger is likely from harvested grain than from forages.

Under similar growing conditions young plants usually contain a higher concentration of nitrate than mature plants. However, the possibility of interrupted growth of the plant increases during advanced maturity which could cause higher build-up of nitrates in the older plant.

**WATER SUPPLY AS A SOURCE OF NITRATES**

Both nitrates and nitrites are water soluble, moving with the water in the soil. Consequently, some well water may contain substantial amounts, particularly in wells fed by surface or subsurface water. Other potential sources may be ponds and low areas which trap feed-lot drainage or collect surface water from fertilized fields.

**SILO GASES-POSSIBLE DANGER TO HUMANS AND ANIMALS**

Silo gases may accumulate on top of fresh silage made from forages high in nitrate. These gases are a mixture of oxides of nitrogen formed from fermentation and heat in the ensiling process. They are deadly and some may be recognized by their yellow, red, brown or reddish-brown color and often irritating odor. They are heavier than air and tend to accumulate just above the silage— they then travel down the chute and drains.

Breathing these gases may cause death or lung damage often called "silo-filler disease." The following precautions should be followed:
1. Always run the blower to ventilate the silo and chute for 10 to 15 minutes before entering the chute.

2. Remove doors just above the silage to allow gases to escape. Never jump down into the silo.

3. Never enter the chute when colored gases or irritating odors are noticed.

4. Keep children and animals away from the silo and drainage area for at least two weeks after filling.

5. Reventilate the silo before opening it for feeding. Use caution when opening doors or plastic covers.

POSSIBLE EFFECTS OF FEEDING NITRATE FEEDS TO CATTLE

The ruminant is able to use some non-protein nitrogen in the ration because rumen microorganisms incorporate it into usable bacterial protein. Likewise, low levels of nitrate may be used by the ruminant.

Table 1. Estimated toxicity of nitrate level 2/

<table>
<thead>
<tr>
<th>ppm of NO₃</th>
<th>Estimated effect</th>
<th>ppm NO₃ in dry matter</th>
<th>Estimated effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-44</td>
<td>not harmful</td>
<td>0-3000</td>
<td>safe, no ill effects with adequate Vitamin A</td>
</tr>
<tr>
<td>45-132</td>
<td>slight possibility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>133-220</td>
<td>possibility, especially over long period</td>
<td>3,000-5,000</td>
<td>possibility of economic loss and mortality</td>
</tr>
<tr>
<td>221-440</td>
<td>Vitamin A interference syndrome likely</td>
<td>over 5,000</td>
<td>potentially toxic</td>
</tr>
<tr>
<td>441-660</td>
<td>more serious, possible acute losses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>661-880</td>
<td>increased possibility, acute losses, with secondary diseases possible</td>
<td></td>
<td></td>
</tr>
<tr>
<td>880 and over</td>
<td>heavy acute losses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2/ Most levels do not have the same degree of toxicity under all conditions. Estimates are based on observation and research at Missouri, Iowa, Illinois and Indiana.
can readily see, most of these symptoms could be attributed to other diseases. Therefore, it is extremely important to get an accurate diagnosis quickly from a veterinarian.

Some effects associated with lower levels of nitrate are unthriftness, hunger, initial vitamin A deficiency and decreased milk production.

The toxic level for acute nitrate poisoning depends upon several factors. These include the concentration of nitrate in the feed, rate of intake, body weight of the animal, the ability of some animals to adjust to nitrate feeds, and the amount of nitrate in the total ration (including the water supply). Table 1 contains estimated toxic levels which may serve as a guide.

On the basis of present knowledge, most of the forages can be used as feed for livestock with little, if any, concern about the toxic effects. Samples of roughage containing 500 to 1000 ppm nitrate (on a dry matter basis) might cause a slight decrease in milk production, and those containing 1000 to 3000 ppm can cause more economic losses. Samples containing 3000 to 5000 ppm can cause some mortality as well as other economic losses. The samples containing above 5000 ppm, consisting of somewhat less than 3% of the samples tested to date, can be considered potentially dangerous and even these can be used with proper adjustment of the ration.

RECOMMENDATIONS

Forages, regardless of the nitrate content, can be ensiled. However, certain precautions should be observed in handling and feeding silage made from these high nitrate crops.

1. Do not enter a silo for seven days after filling unless absolutely necessary. When filling, let the blower run for 10 to 15 minutes before entering.

2. Always watch for signs of silo gas such as nasal or lung irritation, penetrating odor, yellow, red or brown colors, or dead birds or animals at the bottom of the silo chute.

3. If silage is high in nitrates (3000 ppm or above) feed limited amounts over a long period of time by diluting with low nitrate feeds, such as grain or hay.

4. Nitrates have an adverse effect on the conversion of carotene to vitamin A; therefore, feed a level of 30,000 IU (Minimum for adult cattle) of supplementary vitamin A per animal per day.

5. If silage is suspected of being toxic, feed only a few animals for several days rather than subjecting the entire herd to the possibility of nitrate poisoning. Introduce potentially toxic silage into the ration gradually.
6. The tolerance for nitrates is quite variable among animals in different environmental conditions; however, it is increased when animals are being fed on grain with adequate protein supplement.

7. Limited observations indicate that the addition of 20 pounds of ground limestone per ton of corn as it is put in the silo will reduce the nitrate content of silage.

8. In no case should animals be started on a high nitrate feed (3000 ppm or above) when they are hungry.

9. Consult your veterinarian in cases of suspected nitrate toxicity.