FORAGES FOR ALL SEASONS

Managing forages to minimize nitrate poisoning

David W. Koch, Extension Agronomist, Department of Plant Sciences
Steven Paisley, Extension Beef Specialist, Department of Animal Science

Nitrate's effects on livestock can be minimized if conditions for nitrate accumulation are understood and appropriate management steps taken.

Environmental conditions cause toxic levels of nitrate in some forages in Wyoming every year. Nitrate's effects on livestock can be minimized if conditions for nitrate accumulation are understood and appropriate management steps taken.

Plant roots absorb mainly soil nitrate. Nearly all nitrate is reduced once inside a plant to form amino acids and, subsequently, proteins. However, under some stress conditions, nitrate can accumulate to toxic levels in plants. Nitrate in forages consumed by livestock is converted to nitrite by rumen bacteria. Therefore, ruminants are most affected. Toxicity results when nitrite accumulates faster than it is reduced to ammonia. Nitrite in the blood converts hemoglobin to methemoglobin, preventing oxygen transport and causing an animal to die from asphyxiation. Non-lethal nitrate levels can cause abortion and / or reduced milk production.

Factors Affecting Nitrate Accumulation

Plant species. Nearly all plants contain some nitrate. Some of the highest accumulators are weeds such as pigweed, kochia, lambsquarters, and sunflower. Sorghums, including sudangrass, sudangrass hybrids, and grain sorghum, have a reputation for storing nitrate. Among the cereals, oat seems to be the most prone to having high nitrate levels. Under some conditions, corn and other forages can accumulate nitrate sufficient to be toxic to animals. Legumes and cool-season perennial grasses rarely have toxic levels of nitrate.

B-1122.8

UNIVERSITY OF WYOMING
Cooperative Extension Service

Oat

Plant parts. Nitrate is highest in the lower one-third of the stem. Nitrate reductase enzyme levels are high in the leaves and prevent buildup of nitrate in leaf tissue. Very little nitrate is found in the grain.

Plant maturity. Generally, nitrate concentration is highest in the boot stage (just before head emergence) and dilutes as the plant matures if conditions are suitable for continued maturation. Stress at any stage of plant development can induce accumulation of nitrate. New regrowth can be high in nitrate.

Drought. Even under water stress, plants can continue to absorb soil nitrate. High temperatures, which are often associated with drought, can inhibit enzymatic conversion of nitrate. With a drought-ending rain, surviving plants rapidly absorb nitrate and accumulate it in large amounts in the stems. It will require a plant seven to fourteen days following a significant rain to reduce an elevated level of nitrate.

Other environmental factors. Hail can increase nitrate hazard in two ways. Hail usually reduces leaf area, leaving a higher proportion of stems where nitrate is in higher concentration. Also, the stress of reduced leaf area reduces nitrate conversion. Frost can act in the same way as hail, particularly in plants that require a hard freeze to kill. Nitrate can be readily absorbed at temperatures below 50^0 Fahrenheit, but enzymatic conversion is slowed at these temperatures. For this reason spring and fall growth can pose more of a risk than summer growth. Forages harvested or grazed after several days of cloudy weather have been found to contain higher nitrate levels than after sunny weather. Nitrate content of forage can decline from morning to afternoon on sunny days.

Nitrogen fertilizer. Fertilizer and / or manure application increases soil residual nitrate and, therefore, the tendency of nitrate to concentrate in forages. Plant species, stress factors, and plant growing conditions seem to be more important, however, than the amount of nitrogen fertilizer applied. An imbalance of soil nutrients caused by low availability of phosphorus and potassium can contribute to nitrate accumulation. Splitting the seasonal application and limiting nitrogen fertilizer to 50 pounds actual nitrogen per harvest or grazing will help avoid nitrate accumulation. If soil tests show high nitrogen, reduce or eliminate nitrogen application. Apply phosphorus and potassium according to soil test.

Other factors. Herbicides such as 2,4-D can temporarily increase nitrate content of forage and weeds; however, since many weeds store nitrate at high levels, overall hazard can be reduced if weeds are killed. Weeds damaged but not killed, however, will have high nitrate levels because of decreased leaf area and reduced enzyme activity. Plant diseases that interfere with normal growth have been reported to increase nitrate accumulation.

Forage utilization

Ensiling forage will reduce nitrate through the fermentation process as much as 50-60% within a month. Silage can still be a hazard if nitrate is extremely high before ensiling. Haying will not reduce nitrate content, but high cutting (6 to 12 inches) will leave the portion of the crop highest in nitrate in the field.

Avoid grazing immature forage unless it is shown to be safe by forage testing. Avoid grazing the lush new growth after a drought-ending rain or a hail that destroys a significant amount of leaves. Allow seven to fourteen days of plant growth before grazing. Feed animals prior to grazing and turn animals out in mid-afternoon when nitrate concentration of forage tends to be lowest. Animals can adapt somewhat to high-nitrate forages if they are first fed dry roughage to limit intake and if the stocking rate is not so high that they are initially forced to eat stems. This will require close monitoring as grazing progresses. If grazing sorghums or sudangrass, be aware that prussic acid can also be a hazard. Prussic acid develops under similar conditions as nitrate accumulation. See *Managing forages to minimize prussic acid poisoning* for further information.

Green chopping can be more hazardous than grazing forage because livestock consume the whole plant. Green chop should be fed immediately because as forage heats, nitrate is converted to nitrite, which is highly toxic.

If on the basis of lab analysis forage is high in nitrate, special precautions are needed. Hay low in nitrate can be blended with high-nitrate hay. Grinding and mixing with low-nitrate hay is the best way to dilute high-nitrate hay. Alternatively feeding high and low-nitrate bales often results in aggressive animals eating first-fed hay, leaving other animals to gorge on later-fed hay. Close monitoring is needed in order to prevent individual animals from consuming excessive amounts of high-nitrate hay. Avoid feeding damp hay because it tends to become more toxic. Over time, animals normally become adjusted to higher nitrate contents, and the amount of high-nitrate feed can be increased. Feeding a few pounds of grain dilutes the amount of nitrate as well as providing the energy to enhance rumen bacterial conversion of nitrite to ammonia. Animals that are stressed from hunger, sickness, pregnancy, or lactation have a lower tolerance for nitrate than healthy animals. Plenty of clean water free of nitrate will help dilute forage nitrate. Do not allow animals to drink runoff from feedlots, heavily fertilized fields, or manure disposal areas. The total amount of nitrate consumed by the animal, including that in forage and water, determines toxicity.

Sorghum

Checklist for Reducing Nitrate Toxicity

- Collect representative samples of species most likely to accumulate nitrate, particularly if one or more of the above stress factors have occurred. Contact your local University Extension Educator for advice on sampling for nitrate analysis, submitting samples to the lab, and interpreting lab results.
- Avoid heavy nitrogen fertilizer or manure application on annual forages, particularly if they are not irrigated or if water will be lacking. Delay harvesting or grazing stressed forage. Allow forage seven to fourteen days to grow out following drought-ending rain, hail, or light frost that does not totally kill the crop.
- Harvest hay at 6 to 12-inch stubble height to reduce nitrate in stored feed. If a clear day is anticipated, wait until afternoon to harvest. If forage is high in nitrate, it will be easier to control access and utilization with hay feeding than with grazing. Grinding and mixing high-nitrate with low-nitrate hay is by far the best way to reduce toxicity.
- Do not allow green chop forage to heat before feeding.
- Remember that ensiling significantly reduces the nitrate levels of forage.

Senior Editor: Vicki Hamende, College of Agriculture, Office of Communications and Technology
Graphic Designer: Tana Stith, College of Agriculture, Office of Communications and Technology

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Glen Whipple, Director, Cooperative Extension Service, University of Wyoming, Laramie, Wyoming 82071.