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Preventing Nitrate Problems in Drought-Damaged Corn

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Nitrate and aflatoxin poisoning are two problems encountered with attempts to utilize drought-damaged corn. Under certain unfavorable conditions, each requires special management, handling, or conversion processes before such corn can be fed to livestock. The desire of many growers to redirect damaged corn fields to silage, greenchop, or pastures has resulted in livestock death when precautions were not followed. Likewise, grain produced during drought may be contaminated with mycotoxins not encountered under normal growing conditions.

Nitrate poisoning is more of a mid- to late-season problem, while field incidence of aflatoxin is usually confined to the end of the growing season, after the silks turn brown. While nitrate poisoning can also occur when livestock have access to nitrate fertilizers or contaminated water supplies, this report is confined to excess nitrate accumulations occurring under drought conditions in grain producing field crops.

Nitrate Accumulation. High rates of nitrogen fertilization often precede outbreaks of nitrate poisoning. Under drought conditions the uptake of nitrates may exceed the rate of protein synthesis, especially as nitrogen uptake increases as ears approach silking. High temperatures, large losses of leaf area, failed pollination, limited water uptake, and low phosphate adsorption may each create conditions trapping nitrates in the stalk below the ear shoot. Unable to produce enough carbohydrate by photosynthesis to combine with nitrite ions, these plants have the highest accumulation of nitrates near the base of the stalk. If no ear is formed or if ears cannot be pollinated, these plants will accumulate the largest stores of nitrates.

With moderation, even this accumulation may be toxic when fed to livestock. The hazard could also be short-lived if the corn retains enough leaves to stay alive and ears were formed. If ample rain is received, a few days of normal growing conditions will flush out the accumulated nitrates and near-normal levels will be restored. But if the corn is killed by drought, then there is no escape for the trapped nitrates except by leaching. Using these plants as forage becomes increasingly difficult.

Unable to supply enough carbohydrate to combine with nitrates from soil-applied fertilizers, corn plants accumulate nitrogen in the lower stalk until night temperatures cool enough for photosynthesis proceed.

Plants which often accumulate nitrates under drought conditions include field crops, weeds, and vegetables, especially corn, forage sorghums, and grain sorghums.

Poisoning Symptoms. The symptoms of acute nitrate poisoning in livestock include staggering gaits, muscle tremors, rapid pulse and urination, labored breathing and blueing of the mucous membranes (cyanosis due to lack of oxygen), and abortion (which may occur when acute nitrate poisoning kills the fetus but not the cow). The blood on post mortem examination will be chocolate-brown in color. Death occurs from asphyxiation.

The nitrate ion (NO_3) when ingested, is reduced to the nitrite ion (NO_2), which is readily absorbed into

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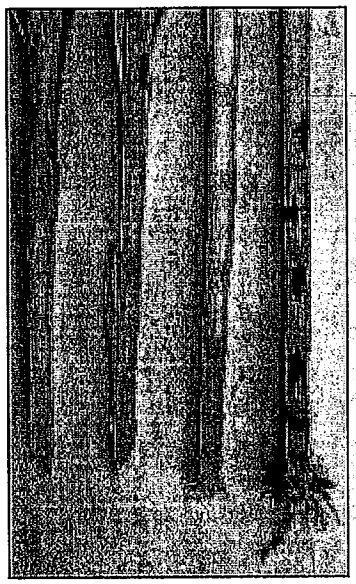
the animal's circulatory system. The nitrites combine with the hemoglobin molecule and decrease the oxygen-carrying capacity of the blood.

Before harvesting or grazing drought-stressed corn or sorghum fields, visit with your veterinarian regarding the specific recommendations to follow. The adverse effects of excessive nitrates in livestock are of such a nature that "time is of the essence." One remedy is an early intravenous injection of 4 milligrams of methylene blue per pound of body weight in a 4 percent solution with distilled water.

Prevention. Livestock may break into corn fields if they are hungry and fences are in poor condition. If possible, herds should be moved to a more secure location or a hot wire should be installed to protect the fence.

Testing for Nitrates. The diphenylamine quick test has been used in the field to determine tissue nitrate levels greater than 1 percent. The reagent is composed of 0.10 gm of diphenylamine salt dissolved in 30 ml of sulfuric acid. When contained in a bottle with an eye dropper, the solution can be dribbled onto the exposed pith of split corn stalks and the reaction observed. Within seconds, a blue or blue-black coloration will develop if high amounts of nitrates are present. Faint tinges of blue that rapidly dissipate are considered safe. The test is not quantitative, but it may be useful to determine the need for more accurate testing at a commercial laboratory.



Split stalks treated with diphenylamine reveal dark blue or black color changes where nitrate levels exceed 1% nitrate. Stalks above demonstrated little or no color change, indicating acceptable nitrate levels.

The plant to be tested should be cut at the soil level and the stalk split lengthwise, with the exposed pith facing upward. Either place it on the ground or hold it at a 45-degree angle away from you. Allow some test solution to fill the dropper and let a drop fall on the pith 2 to 3 inches from the base of the stalk. Let another fall about 8 inches up, and place others further up the stalk. You will generally find that the reagent immediately turns dark blue or black where nitrates are present at levels greater than 1 percent. If you split an ear, a leaf midrib, or a tassel, you would probably find only a mild tinge of blue or no color change at all. It is the bottom 12 to 18 inches of stalk that contains most trapped nitrates.

Consult your local soil or plant tissue testing laboratories for instructions on nitrate testing, quantities required for sampling, and fees for analysis.

Utilizing Damaged Plants. With pastures fully used-up and dormant from high temperatures, livestock owners often consider salvaging some feed value from ruined stands of corn. The growth state of the corn may determine the option being considered. Fields of corn damaged by drought may have corn in all stages of development. Emergence is often uneven, and the parts of the field with better soil moisture may be the only plants to achieve normal plant height or to produce an ear. Early in drought, leaves begin to yellow and die back from the blade tip and edges. Leaves progressively die back from the bottom and up the stalk. Loss of the ear leaf and upper leaves seriously affects grain yields. Below terraces or shallow slopes or compacted areas, corn may produce a nubbed ear, a barren cob, or a partially filled ear. Remember that nitrate accumulations are greatest in the lower 12 to 18 inches of stalk. Nitrates decline in the proximity of

Drought stressed corn rolls leaves mid-morning to late afternoon. Progressive leaf loss proceeds from bottom to top of plant.

the ear, if one is present. Leaves, tassels, and the upper stalk are usually safe from high NO_3 levels. The following options and precautions have been practiced in drought years.

Cattle can be conditioned to eat larger amounts of feed with a higher nitrate content if the increase is gradual. Healthy animals are less likely to be affected than sick animals. Animals consuming carbohydrates can tolerate more nitrate.

Silage. Unlike prussic acid (which volatilizes in hay with curing), nitrates do not totally dissipate in the ensiling process or when plants are left to field drying. Some nitrates will be converted to gaseous forms of nitrogen and will escape as silo gas, while other nitrates will be lost if the silage "runs" and seeps liquid during fermentation. This discharge should be considered dangerous and should not be accessible to livestock. Most silage will be acceptable, because 30 to 60 percent of the nitrates are lost in this way.

The best silage includes grain as well as foliage. There is a tendency to rush the making of silage, which may be the wrong thing to do. Fields should not be ensiled until dry matter (DM) reaches 28 to 36 percent. If corn is ensiled below the 28 DM without sufficient earing, there are not enough carbohydrates present to have proper fermentation, and quite often a putrid silage will develop with excessive seepage (lost nutrients). When working with upright silos, there is always a possibility of accumulations of nitrogen dioxide or nitrogen tetroxide. These two gases may be recognized by their irritating odor and color (reddish brown or yellow). Nitric oxide is a colorless gas that may be present in deadly concentrations without visibly being detected.

Silage from damaged corn should be tested again for nitrates and fed so as to not provide excessive amounts. Such silage should be introduced slowly and modulated with other feeds as needed. Many nitrates can be excluded in the harvesting process by setting the cutter bar high to leave the lower portion of the stalk in the field. If plant material is too dry, it may be necessary to add some water to the harvested crop material to maintain a satisfactory fermentation process and to establish airtight conditions. The rule of thumb would be to add 4 gallons of water per ton of silage for each 1 percent desired increase in moisture content. This should be added at the time the chopped forage is being put into the trench or silo. Silage requires a minimum of 21 days for fermentation.

Pasturage. Putting up hot wires and allowing livestock to graze the damaged corn (free choice) is more risky, but requires fewer facilities, labor, or equipment. Cattle should have access to good hay before they are turned into the damaged field. This permits a slower introduction to possible nitrates. Many producers have experimentally turned-in one or two older cows to test the hazards of feeding from the damaged field. If no problems are encountered in a reasonable time, the balance of the herd may be brought in. Cattle may selectively eat ears, leaves, and tops with less preference for stalks, but this is not always so. Hungry cattle may devour everything available. Do not turn hungry cattle into suspect fields.

Hand-Feeding Greenchop and Cut Stalks.

If feed is needed badly, you can select for the better plants or parts of the field with the lowest nitrate levels. These can be greenchopped for livestock after spot testing with diphenylamine. Although some plants may test high in nitrates, when mixed with other plants and plant tops, these levels should be lower. In addition, handcut or greenchopped stalks can be harvested above the 12- to 15-inch level to avoid the highest nitrate accumulations. Greenchop can be fed in bunks after cattle have been fed full of hay. This will also dilute the effect of individual plants with high levels. It is the percentage of nitrate in the total ration being consumed that is important. The following cautions should be observed:

- **Don't hold green chop overnight or let it heat or spoil.** A delay in feeding corn forage after it has been chopped will increase the conversion of nitrates to nitrites by bacterial action.

- **Don't feed cattle more than they will eat in a few hours.** Start cattle on greenchop slowly. Have cattle full of other feed.

- **Feed greenchop twice daily.** Do not hold second feeding from morning to evening in a wagon. It would be good to feed 5 pounds per head twice daily for the first few days, then go to 10 pounds per head twice daily for a few more days and 15 pounds after 7 to 10 days.

• **Supplement greenchop with other feeds to meet daily nutrient requirements.** A mature cow will need about 4 pounds of corn or about 8 pounds of hay in addition to greenchop to balance minimum needs.

• **Do not feed high urea supplements with greenchop with high nitrates.**

Baling Stalks in Round Bales. As previously discussed, curing and making rough hay from droughted corn does not remove nitrates. While these bales can be an important source of supplement to other feeds, they should be tested so that a safe, calculated feeding program can proceed. If such bales are sold to neighbors or standing corn fields are leased for pasturage, appropriate warnings should be given.

Other Plants with Nitrates. Almost any crop plant in the grass family that has received a liberal nitrogen application in a drought year can have potential nitrate problems. Oats, haygrazers, millet, and sorghum have each developed problems under the most unfavorable of conditions. Fall-planted wheat, oats, rye, and other small grains have normally escaped the kind of summer drought that induces nitrate accumulation.

Corn that is ensiled 2 to 6 days after late frost damage can also have high nitrate levels and should be tested prior to use. Ship a small plastic bag of silage to the testing lab or bring it to your county Extension office.

Risk Management. An additional concern to ranchers is the possibility of bloat that comes from the change of feed in turning livestock into damaged corn fields. Fresh corn forage will be higher in nutrients and protein than the previous feed. Cattle should be introduced slowly to the new feed and watched carefully for signs of both bloat and nitrate poisoning.

There is no substitute for a focused, calculated testing program to determine the concentration of nitrates in damaged plant materials. But this is easier said than done. Mixed plant materials are always easier to evaluate than crop plants still in the field.

Localized hot spots exist in the field for nitrates, just as with aflatoxin sampling. Once you have an idea as to how high nitrates are testing, you may be able to adjust a feeding program that will permit the salvage of some forage. Until adequate rainfall flushes nitrates from live corn plants, livestock owners and managers must closely monitor herd health and be ready to withdraw the herd, feed, or provide intravenous injections as required.

This report does not encourage or discourage the use of drought-damaged corn for livestock feeding. It was prepared to provide an awareness of the options, risk, and precautions associated with the buying, selling, or utilizing of these materials as feeds or supplements. No nutritional or toxicological recommendations have been intended, as these cannot be determined without quantitative testing. The local large animal veterinarian, the forage lab with nitrate testing facilities, and the Texas Agricultural Extension Service are each capable of answering specific questions beyond the scope of this publication.

For More Information.

"Nitrate Poisoning in Beef Cattle." Texas Agricultural Extension Service publication BCM-42, 4pp. 1995 Beef Cattle Management Handbook, Texas A&M University System, College Station, Texas.

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