Prussic Acid Poisoning

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It was discovered in the early 1900s that under certain conditions, sorghum is capable of releasing hydrocyanic acid (HCN or prussic acid), which makes them potentially dangerous for grazing. In the plant, HCN is attached to a larger molecule, a cyanogenic glucoside called *dhurrin*. Dhurrin itself is harmless, as it is simply a compound consisting of a sugar and a non-sugar molecule. However, a two-step enzymatic process results in two hydrolysis products with the final one being HCN. Generally, for this process to occur the plant has to be damaged as the glucosides and degradative enzymes are compartmentally separated within the plant cells. This damage may occur through the chewing action of an animal, a hard freeze where plant cell walls are ruptured, or through mechanical action such as that caused by a swather and its crimpers. Once ingested by an animal, the HCN is released in the rumen and readily absorbed into the bloodstream. HCN does not prevent oxygen from being transported by hemoglobin, but does prevent the body cells from receiving oxygen. The site of this inhibition is believed to be the cellular electron transport system where cyanide (CN) blocks the utilization of oxygen. Thus, the animal dies from asphyxiation at the cellular level. Animals affected by prussic acid poisoning exhibit a characteristic bright red blood just prior to and during death.

Plant Factors in HCN Accumulation

Several points of agreement among agronomists, animal scientists, and veterinarians on HCN accumulation in sorghum plants include:

1. Young, growing plants contain more HCN per unit weight than older plants.
2. Any stress condition such as drought or freeze damage can increase HCN amounts.
3. There is more HCN in the leaves than stems—the top-most (younger) leaves contain more HCN than the lower leaves.
4. HCN tends to become diluted in older plants, but top-most leaves may still contain dangerous amounts.
5. Sun-curing of hay will reduce HCN, especially if the hay is crimped. Dhurrin will be hydrolyzed and HCN evaporates in gaseous form.
6. Dryland sorghum tends to be higher in HCN potential than irrigated sorghum due to stress on the plant.
7. High nitrogen rates, regardless of phosphorus level, will increase HCN potential.
8. Imbalance of nitrogen and phosphorus in the soil increases HCN potential.
9. HCN potential in sorghum plants is genetically controlled and varies among sorghum types (Table1). Several enzymes are involved in production of amino acids with many genes being involved.

Commercial hybrids which are relatively low in prussic acid potential exist, while others are being developed, but such hybrids are not advertised as “safe” because of the multitude of uncontrollable factors involved. One can never be absolutely certain that a field of sorghum is safe to graze.

Management Practices

Taking a proactive approach to managing for HCN poisoning is preferable to waiting until it happens. The following management techniques will help prevent or minimize losses related to HCN.

1. Do not turn hungry cattle into the pasture. Feed some hay before turning in cattle late in the afternoon.
2. Prevent selective grazing of lush young regrowth by using rotation grazing.

Table 1. Generalizing ranking of sorghum types in their potential HCN accumulations.

Sorghum Types	*HCN Potential*
Piper Sudangrass	Low
Sudangrass X Sudangrass Hybrids	Fairly Low
Sorgo-Sudangrass Hybrids	Intermediate
Sorghum-Sudangrass Hybrids	High
Sorgos (Varieties)	Intermediate to High
Grain Types (Varieties and Hybrids)	High to Very High
Johnsongrass	Generally High
Sorghum Almum (Columbus Grass)	Generally High

3. Allow plants to reach at least 18 to 24 inches in height before grazing is allowed. This management practice permits some dilution of the HCN.
4. Do not graze after frost until all plants are field cured. It is necessary to make sure you have had a killing frost because sorghum plants will initiate tillering with a light frost. The tillers will be exceptionally high in HCN. It is recommended that at least seven days (one week) be allowed after a killing frost before grazing.
5. If environmental conditions in your area are such that HCN poisoning is a consistent problem, check with your seed dealer about varieties or hybrids that would have a low HCN accumulation potential.
6. Take a soil sample from the area to be planted. Do not apply excessive nitrogen fertilizer. Keep soil phosphorus, and pH at an appropriate level for producing sorghum, see OSU Fact Sheet PSS-2225, "OSU Soil Test Calibrations." Soil sampling is essential in managing for HCN.
7. When turning cattle into a field with possible HCN problems, the following is recommended:
   - Turn in only a few cattle at first and see how they do.
   - Ask your local veterinarian to be present in case of problems.

Testing for Prussic Acid

Two types of test procedures are available for determining prussic acid (cyanide levels) in plants. One is a quantitative test and involves sending material to the Oklahoma Animal Disease Diagnostic Laboratory. For this test, care must be taken to avoid volatilization (loss of the cyanide gas) as the plant sample dries. If prussic acid has been lost from a sample prior to analysis, the test result can be misleading. In order to prevent volatilization, call the laboratory for specific instructions on how to properly submit samples. General guidelines for interpreting results from a quantitative prussic acid test are provided in Table 2.

Table 2. Generalized interpretation for forage prussic acid (HCN) test.

ppm HCN (dry matter basis)	*Interpretation*
0-250	Very low - safe to graze.
250-500	Low - safe to graze.
500-750	Medium - doubtful to graze.
750-1000	High - dangerous to graze.
>1000	Very high - very dangerous to graze.

The second test procedure is a qualitative test. It will not give PPM levels for a sample, but rather an indication of the presence of cyanide. This procedure is relatively new in terms of availability to producers. In this test "Cyantesmo Paper" is utilized to detect the presence of hydrocyanic acids and cyanides in freshly cut plant material. In the presence of cyanide, the pale green paper turns blue. Refer to your County OSU Extension Educator–Agriculture for assistance with the test. They will have the cyantesmo paper, and the tools to use it. The following steps should be utilized when using cyanotesmo paper:

1. Only fresh cut leaf samples are suitable for testing.
2. An air-tight sealable plastic bag should be used for "airtight purposes."
3. Leaves should be immediately placed in a bag and preferably cut up inside the bag to avoid dry down of plant material, which in turn, will result in gaseous volatilization and loss of cyanide.
4. A small piece of cyantesmo paper is placed in the bag with the leaves.
5. If cyanide is present, the strip should turn blue in approximately 5 minutes or less.
6. The strip works best in warm room temperature environments. Avoid excessive heat or cold conditions.
7. Do not expose cyantesmo paper to light for long periods of time.
8. Young Nandina leaves serve as a good positive control test for determining if cyantesmo paper is still active.
9. Very important — Cyanotesmo paper has carcinogenic properties, therefore care should be taken when handling. It is recommended that proper eye protection and gloves be worn when handling.

Summary

There are no totally reliable quick test methods of determining the amount (ppm) of prussic acid that may have accumulated in sorghum plants. Livestock producers should be cautious about grazing plants that have been subjected to stress. Danger can be reduced by planting a variety or hybrid that is low in prussic acid potential and by using preventative management practices.

The environmental scenarios that enhance prussic acid accumulation are similar to those of nitrate toxicity. For information regarding the factors involved in nitrate toxicity refer to Extension Fact Sheet PSS-2903, "Nitrate Toxicity in Livestock."

Oklahoma Animal Disease Diagnostic Laboratory

http://www.cvhs.okstate.edu/index.php?option=com_content&task=section&id=23&Itemid=434
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