Prussic acid poisoning

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It's been known for many years that some crop plants are poisonous to animals. It was suggested in 1803 and confirmed in the early 1900's that certain plants were poisonous because they contained prussic acid (also called HCN, hydrocyanic acid, hydrogen cyanide, or cyanide).

How prussic acid poisons

Such plants produce prussic acid only under certain circumstances. The cyanogenic (prussic acid producing) compounds are located in one part of plant cells, while the enzymes which trigger prussic acid production are located in another. Under normal conditions, there is no contact between the two.

However, anything which causes the plant cell to rupture allows them to combine and form prussic acid. Plant cells are ruptured by cutting, wilting, frost or freezing, drought, crushing, trampling, chewing, or chopping.

Once plants containing prussic acid have been eaten, the toxin rapidly enters the blood stream and is transported to the tissues, where it inhibits the utilization of oxygen by the cells. It causes a form of asphyxiation.

Symptoms

Prussic acid is a potent, rapidly acting poison, frequently killing within a few minutes; often, the animals will be found dead.

Clinical effects occur in rapid succession. There may be difficult breathing, stupor, staggering, and convulsions. The blood becomes a bright cherry red and often clots slowly or not at all.

Autopsy of dead animals shows congestion and petechial hemorrhage of the intestine and fourth stomach (abomasum) and congestion of the lungs and trachea. The smell of "bitter almond" **may** be present in **fresh** rumen contents.

Feeds involved

Prussic acid poisoning is most often associated with sorghums and sudangrass. It can also occur in a number of other plants; Johnsongrass, flax, arrowgrass, birdsfoot trefoil, chokecherry, wild cherry, black elderberry, white clover, cassava, velvetgrass, and Christmasberry.

Danger of prussic acid poisoning is greatest at immature stages of growth and decreases with maturity. Therefore, plants harvested at immature stages may be higher in prussic acid than when allowed to fully mature. This is the case with regrowth or second growth which is often harvested or grazed at immature stages. If allowed to mature, second growth has no greater potential to release prussic acid than the first growth.

Generally speaking, the short, dark green plants have the greatest potential for prussic acid poisoning.

Except at very immature stages, prussic acid accumulates largely in the leaf portion of the plant.

Heredity is connected to prussic acid content in sorghums; some strains tend to be higher in prussic acid than others. Grain sorghums are higher in prussic acid than forage sorghums, and sorghum-sudangrass crosses fall in between. One forage sorghum (publicly developed) which is low in prussic acid is Piper sudangrass. However, low prussic acid strains may, under extreme conditions, contain dangerous levels of the toxin.

Frost

Frost or freezing causes plant cells to rupture, thus allowing prussic acid to be released if the potential already exists. If the potential for the poisoning is great before freezing (high concentrations of prussic acid containing compounds are present), then the danger of poisoning is very great while the plant is frozen and for a week or two following. It is during this time that prussic acid is being released by the plant.

Note that if the potential for prussic acid poisoning does not exist in the plant before freezing, there is no added danger caused by the freeze.

Consequently, it is not advisable to graze sorghum, sudangrasses or other cyanogenic plants during or immediately after frost unless you are absolutely sure there is no potential for prussic acid poisoning in the plants.

Drought

Drought increases the chance for high levels of prussic acid in plants. In fact, it is under drought conditions that most cases of poisoning occur. This may be because the plants have not been able to mature.

Fertilization

Prussic acid content in plants appears to be favored by soils high in nitrogen and low in phosphorus.

Curing

There is a gradual loss of prussic acid from plants during drying or curing. There is no rule of thumb as to how much prussic acid is lost or how fast. Curing in the sun seems to be more effective than curing in the shade, possibly because of the higher temperature.

Chopping

Chopping or ensiling plants high in prussic acid usually results in substantial loss of the toxic substance. Again, there is no rule as to how much is lost or how fast.

Plants high in prussic acid should not be fed immediately after green chopping; sufficient time should be allowed for the release of any newly formed prussic acid. A week or two should be enough.

Chopping high prussic acid forage has an additional advantage over grazing. Grazing animals tend to eat mostly leaves, where prussic acid concentration is greatest. Danger of poisoning is less with green-chop feeding, where the entire plant is consumed.

Confusion with nitrate poisoning

Prussic acid poisoning should not be confused with nitrate poisoning which is also a problem with certain forages, especially under drought conditions.

Since both poisons cause a type of asphyxiation in livestock, the clinical signs are often very similar. They can be distinguished by the color of the blood, which in the case of nitrate poisoning is a dark chocolate brown, and in the case of prussic acid poisoning a bright cherry red.

It is not impossible that a drought stunted sorghum or sudangrass crop may be high in both nitrates and prussic acid, since drought conditions are favorable for the accumulation of both.

For further information on nitrate poisoning, see Fact Sheet 420

Control measures

The chance of prussic acid poisoning is small, even during periods of drought.

Matured sorghums, sudans, and other cyanogenic plants will not usually have high levels of the prussic acid containing compounds. Even if the level of these compounds is dangerously high, conditions will not often be right for the release of the toxin. A large percentage of farmers and ranchers in the state will never have trouble from prussic acid poisoning.

With this in mind, the following suggestions are offered:

1. The danger of poisoning can be reduced by offering other feeds along with high prussic acid feed, thus reducing intake of the dangerous feed. It has also been suggested by several authors that feeding high starch feeds with the high prussic acid feed reduces the potential toxicity, but this is not well established. Limited feeding, as opposed to full feeding of the dangerous feed, should reduce potential toxicity problems.

2. Curing, chopping, or ensiling feeds should reduce the level of prussic acid. Be sure to wait a week or so after chopping if green-chop is to be fed.

3. Allow a week or so following a frost or freeze before grazing or feeding a sorghum, sudangrass, or other cyanogenic crop.

4. When considering pasturing or grazing a suspected forage, keep in mind that the leaves are higher in prussic acid than stems or stalks.

5. Young, short, dark green plants are the highest in prussic acid. Allowing plants to fully mature reduces danger of prussic acid poisoning. Avoid feeding or grazing second growth at immature stages.

6. A prussic acid analysis of suspected feeds can be helpful, and in some instances is advisable. The analysis may not give a “yes” or “no” answer, but can be helpful in estimating potential toxicity.

Treatment

The treatment of prussic acid poisoning is not generally highly effective, because it is usually applied too late. However, when animals are lost and the cause is immediately recognized as prussic acid poisoning, other animals which have been affected and are still alive may be saved by a veterinarian.

A recommended treatment is the intravenous administration of a mixture of 1 ml of 20% sodium nitrite and 3 ml of 20% sodium thiosulfate, giving 4 ml

of this mixture per 100 pounds body weight. Commercial solutions for treatment of prussic acid poisoning are available.

In the special case where toxic concentrations of prussic acid and nitrate coexist, the sodium nitrite should be omitted from the treatment due to the high levels of nitrate already ingested. Further, since the clinical signs of nitrate and prussic acid poisoning are so similar, and because nitrite is used in the treatment of the former, it is very important to make the correct diagnosis before treatment.

When livestock losses occur and prussic acid poisoning is suspected:

1. **Contact your veterinarian.**

2. Send sorghum, sudangrass. flax, or other suspect samples for analysis. Do not send grains, stomach contents, or blood samples. Always send an explanatory letter with the samples. Since there may be loss of prussic acid, samples should be delivered to the laboratory as soon as possible. This is particularly true of samples which have been chopped. Unchopped samples are preferred.

3. Change feeds, if possible, until results of analyses are returned.

Instructions for sampling

In collecting material for analysis, get as representative a sample as possible.

When a field is sampled, combine material from various parts of the field. When a stack is sampled, forage from many points within the stack should be combined. The amount to send will be determined by the amount that is necessary to obtain a reasonable representative sample.

The time between sampling and delivery to the laboratory should be kept as short as possible to prevent loss of moisture and prussic acid. Send chopped samples in plastic bags or tight containers.

Do not send grains, stomach contents, blood, or tissues, since these do not assist in diagnosis.

Mail early in the week to avoid any over-weekend delay in a post office.

Send samples to Station Biochemistry, South Dakota State University, Brookings, South Dakota 57007. Be sure to enclose a note with your name and address and the analysis you wish made.

Interpreting a prussic acid analysis

Prussic acid analysis of plants estimates the **potential** of the plant to cause poisoning. During the analysis the plant cells are broken, allowing the cyanogenic compound to mix with the plant enzymes, which release the prussic acid. The prussic acid is then trapped and measured as a gas.

It must be considered that many variables beside prussic acid content would influence potential toxicity. These include 1) the amount of plant material ingested; 2) the size and kind of animal involved; 3) the type of food ingested simultaneously; 4) the possibility of plant enzymes remaining active in the digestive tract of the animal; and 5) the ability of the animal to detoxify the prussic acid it encounters.

There can be loss of prussic acid during shipment of the samples, and this somewhat limits the reliability of an analysis in predicting the potential for poisoning. Nevertheless, with reasonable precautions, the losses may be minimized.

The following guide must, therefore, be used with judgment. It is based on experimental work and observations, and provides a reasonable margin of safety. **If the sample being analyzed is representative of what is being fed, the analysis should be helpful.**

Prussic Acid (HCN) Content (dry basis)	Comment
Less than 600 ppm*	This feed should not cause prussic acid poisoning.
600-1800 ppm	This feed may be potentially toxic; it should be fed at a restricted rate. If pastured, animals should be put on only during that part of the day when they can be observed frequently and can be removed if they show any signs of discomfort.
Over 1800 ppm	This feed is potentially very toxic so it should be fed at a very restricted rate, if at all. Drying or ensiling or allowing it to mature more fully should reduce its prussic acid content.

*ppm = parts per million. Where results are reported on a wet or "as is" basis and the moisture content is not known, divide the prussic acid value by 3 before making an interpretation.

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