MARYLAND COOPERATIVE EXTENSION

Fact Sheet

Fact Sheet 427

What Is Prussic Acid?

Sudangrass, sorghum, and sorghum-sudangrass hybrids are among a group of plants that produce cyanide, which can poison livestock under certain conditions. Also included in this group of plants are johnsongrass, chokecherry, and black cherry. These plants produce cyanogenic glycosides during their growing stage. Glycosides are compounds containing a carbohydrate (sugar) and a noncarbohydrate residue in the same molecule. They decompose (breakdown) into glucose sugar and the noncarbohydrate residue by hydrolysis (addition of water) as a result of enzymatic action. In cyanogenic plants this decomposition frees the cyanide from its chemical bond, and it becomes toxic hydrocyanic acid, frequently called prussic acid, and abbreviated HCN. The intact, still-bonded cyanide and glucose are not poisonous. But, when certain enzymes are present that break the bond and free the cyanide, prussic acid (a highly toxic poison) is formed. The enzymes involved in this chemical decomposition of the cyanide and glycosides usually are present in the same plant—but may be available from other sources. Animal digestive juices are a probable source.

Under normal growing conditions, the intact glycoside occurs in the plant. When animals eat plants containing intact glycosides, they are eliminated readily before the concentration becomes harmful. Certain conditions involving climate, fertility, stage of growth, and anything that retards plant growth and development may increase cyanogenetic glycosides in the plants. A rapid regrowth following a period of retarded or stunted growth favors the increase of glycosides. Wilting and frost injury may cause a rapid increase of prussic acid in a plant that would otherwise have been nontoxic. Livestock owners should use caution in grazing animals on plants that contain appreciable quantities of this poisonous substance.

Sorghum is much higher than sudangrass in prussic acid, and, in general, sorghum is unsafe for pasturing except after plants reach maturity and no new growth is present. Sorghum silage may contain toxic quantities of prussic acid, but it escapes in gaseous form when the silage is moved and fed. Under most circumstances, silage and well-cured stalk residue can be safely fed to stock. Prussic acid is released very quickly from the glycoside form in frozen leaves. Therefore, frosted sorghum is very dangerous to feed until it begins to dry out.

Usually there is little danger of prussic acid poisoning in grazing most varieties of sudangrass and sorghum-sudangrass hybrids. However, the young growth that follows clipping, drought, frost or grazing may contain appreciable quantities of prussic acid. If favorable weather for growth follows a killing frost, these plants will send forth new shoots and leaves which are likely to be very high in prussic acid and, if pastured, cause poisoning.

How Does Prussic Acid Affect Animals?

Young plants and leaves of sudangrass and sorghum contain the cyanogenic glycoside *dhurrin* (or *durrin*). Also present in these young plants and leaves is an enzyme called *emulsin*, which breaks down some of the harmless glycoside *dhurrin* to release prussic acid. If plants are damaged by freezing, chewing or trampling, then *emulsin* can more easily free larger quantities of the poison; thus, the hazard.

Various species of animals react differently when they eat plants containing these glycosides. These differences are caused by different anatomical structures and different detoxifying abilities of various animals. Cattle and sheep, both being ruminants, are known to be subject to poisoning by cyanogenic

glycosides. The rumen of these animals is neither strongly acid nor alkaline, and it contains a large flora of micro-organisms and considerable quantities of enzymes. This is an excellent medium for the formation of prussic acid, which is then rapidly absorbed into the blood. Horses and swine, being nonruminants, each have only one stomach which is strongly acidic due to the presence of hydrochloric acid (HCl). The HCl reacts with the liberated HCN to form much less toxic substances—formic acid and ammonium chloride.

The toxifying action of HCN is almost immediate; that is, as soon as it is liberated from the glycosides. The specific action of prussic acid on livestock is that it combines with hemoglobin to form cyanoglobin, which does not carry oxygen. Thus, the animal's tissues are without oxygen. The cyanide-poisoned animal shows an increased rate of respiration, increased pulse rate, gasping, muscular twitching or nervousness, trembling, foam from the mouth, blue coloration of the lining of the mouth, and spasms or convulsions; death occurs from respiratory paralysis. Often, blood passes from the nostrils and the mouth near the time of death. The clinical signs are seldom seen because most HCN-poisoned animals die within minutes, once the toxic agent enters the bloodstream. Usually the animal dies within 15 to 20 minutes after consuming the forage. It only takes a dose of about 1 gram of HCN to kill a 1,000-pound cow. The amount may vary somewhat depending on the detoxifying capacity and physical resistance of the animal.

It is estimated that a 1,000-pound cow should be able to detoxify at a rate of about 0.5 gram of HCN per hour. It is therefore possible for cattle and sheep to consume forage containing small amounts of HCN without ill effects or signs of cyanide poisoning. It is only when the poison enters the blood stream at a greater rate than the detoxifying rate of the animal that fatal poisoning follows.

Detoxification of the cyanide to the thiocyanate is a rapid process; the animal that eats quickly is at greatest risk since the rate of cyanide formation exceeds that of detoxification. Levels of 0 to 25 milligrams (mg) HCN/100 grams (g) dry plant tissue have been considered safe for grazing, levels of 50 to 75 mg/100 g as doubtful, and concentrations of greater than 100 mg/100 g as highly dangerous. [1]

What Influences a Plant's Prussic Acid Content?

Soil fertility

Plants tend to have more prussic acid if the soil is high in nitrogen and deficient in phosphorus and potash. An adequate supply of available phosphorus tends to decrease the prussic acid content in two ways:

1. An adequate supply of phosphorus makes possible and speeds up the formation of certain proteins, which use up nitrogen that might otherwise accumulate in the form of cyanide.

2. Phosphorus is an important constituent of nucleo-proteins, which are an essential part of all cells; thus, an adequate supply of phosphorus is needed if rapid cell division and plant growth are to take place. By speeding up cell division, plants more rapidly reach the stage of lower prussic acid content.

It is quite possible that under rates of fertilization commonly applied to annual forages, animals may be exposed to the dual risk of cyanide poisoning and nitrate toxicity. The two conditions have, in fact, sometimes been confused.

Note: Split the nitrogen application to decrease problems. Apply phosphorous and potassium as advised by your soil test report.

Stage of growth

Leaf blades normally contain higher levels of prussic acid than leaf sheaths or stems. Tillers and branches have higher levels than older plants because they are mostly leaves with little stalk material present. Upper leaves contain more prussic acid than older leaves. Thus, prussic acid content of sudangrass, sorghum, and sorghum-sudangrass hybrids is highest in the earlier stages of growth. As plants mature, the stalk content increases, causing the prussic acid content in the total forage to decrease only slightly with plant maturity if animals selectively graze the more tender new growth—those plant parts high in prussic acid.

Short (3 to 4 inches), dark–green sudangrass may contain well in excess of 100 mg HCN/100 g of dry tissue. Amounts approaching 200 mg HCN/100 g dry tissue have been found. As stated previously, amounts in excess of 50 mg HCN/100 g dry tissue are questionable for use as pasture. Once sudangrass plants have attained a height of about 18 to 20 inches and sorghum-sudangrass a height of 24 to 30 inches, HCN content should be at a level less than 50 mg HCN/100 g dry tissue and be safe to pasture.

Note: Sudangrass should not be grazed or green chopped until it has reached a height of at least 18 to 20 inches. Sorghum-sudangrass hybrids should not be grazed or green chopped until they have reached a height of at least 24 to 30 inches. Sorghum is generally unsafe for pasture or green chopping until after plants reach maturity.

[1] 0-25mg/100g = 0-250 ppm = 0-0.025%
50-75mg/100g = 500-750 ppm = 0.050-0.075%
100mg/100g = 1,000 ppm = 0.1%

Species and variety

Sorghums are generally much high in prussic acid than sudangrass. As a group, sorghum-sudangrass hybrids also contain more prussic acid than sudangrasses. Some varieties tend to be lower in prussic acid than others. Growers should select varieties with lower prussic acid potential.

Frost

Prussic acid is released very quickly from the glycoside form in frozen leaves, and hence frosted sudangrass and sorghum-sudangrass hybrids can be very dangerous until they have dried out. The free prussic acid in this forage does not begin to decline until thawing and wilting begin. The forage usually is considered safe to feed after drying for 5 to 6 days.

A light frost may kill only the tops of the plants and leave the lower portion alive. If favorable weather for growth follows such a frost, these plants will send forth new shoots and leaves which are apt to be very high in prussic acid, and, if pastured, cause cyanide poisoning. When this happens, it is, of course, natural to infer that it was the frosted grasses that caused the poisoning rather than the new growth.

Drought

In periods of drought, when sudangrass is less than 18 inches tall or sorghum-sudangrass hybrids are less than 24 inches tall, a high prussic acid content may persist because the grass is unable to grow out of the high prussic acid stage. Drought keeps the plants small at the stage with higher prussic acid concentration. Also, drought can reduce the availability of phosphorus to plants, resulting in the high nitrogen–low phosphorus situation previously mentioned.

Can Potentially Hazardous Forages Be Used?

Pasture

Deaths on pasture are caused partially by animals preferring to graze leaves and young shoots. These plant parts may contain 2 to 25 times more prussic acid than stems. Animals may also shun frost-damaged leaves and shoots to graze any new shoots and leaves that develop after a frost.

Immediately after frost, remove the animals until the grass has dried thoroughly. Frosted foliage contains very little prussic acid after it is dry. Generally, the forage will be safe to feed after drying 5 to 6 days.

If new shoots develop after a frost, sudangrass should not be grazed until the new growth is at least 18 to 20 inches and sorghum-sudangrass 24 to 30 inches tall. This may mean that the crop is harvested as hay or silage since, in most cases, adequate growth for grazing cannot be obtained after frost occurs.

Heavy stocking rates—four to six animal units per acre—and rotational grazing help reduce the hazard of prussic acid poisoning on pasture.

Green chop

Green chop forage usually is safer than the same material used for pasture because it is not selectively grazed. In the case of pasture, only the leaves may be eaten, while with green chop material, the total plant is consumed. Stems may be regarded as safety devices, since they dilute the high prussic acid content of leaves.

Wilted silage

Generally, silage is safe for feeding. It may contain toxic levels of prussic acid while in storage, but much of the poison escapes as a gas when being moved for feeding. *Do not feed new silage for at least 3 weeks after ensiling.*

Hay

The prussic acid content of sudangrass or sorghum-sudangrass hay decreases by as much as 75 percent while curing and rarely is hazardous when fed to livestock.

What Is Proper Grazing Management?

Use this management program to minimize the danger of prussic acid poisoning and provide the most pasturage from a given area.

For continual grazing of sudangrass or sorghum-sudangrass hybrids during the summer months, it is desirable to have the acreage divided into two or more areas so that livestock may be rotated from one area to another. This avoids the necessity of pasturing a field when much of the grass consists of small new growth, as is the case when a relatively large field is slowly grazed down. The dates of planting can be staggered by a week or 10 days each so that all areas are not ready for grazing at the same time.

Rotational grazing has other notable advantages. It makes possible the production of more pasturage from a given area because the grass is allowed to get a good start and produce a large amount of leaf surface before being pastured. It is in the actively growing young leaves that much of the carbohydrate and protein synthesis take place. If these leaves are grazed off as soon as formed, the grass does not rapidly manufacture carbohy-

drate and protein and, hence, does not grow rapidly. In rotational grazing, the plants have the advantage of rapid growth that comes only after a good start.

Still another advantage of rotational grazing is that it causes a more uniform removal of the old growth, and the regrowth obtained will be more palatable.

When the acreage is divided into two or more areas, grazing of a smaller area at a time is possible. This forces the livestock to remove the growth completely and uniformly in a relatively short period of time. The proportionately small amount of new growth produced during this period is mixed with so much older growth that there is little or no danger from poisoning. As soon as the first field is grazed down to a 6- to 8-inch stubble, the livestock are rotated to another area. This gives the grass in the first area full opportunity to produce new shoots and leaves, making possible rapid growth. When the regrowth in this first area has reached the proper height, the field is again ready for grazing. Other areas are managed similarly. If pasture other than sudangrass or sorghum-sudangrass hybrids are available, livestock may be rotated to other pastures and back again.

What Are the Recommended Precautions?

1. Use certified seed. This assures varietal purity.

2. Select varieties that are low in prussic acid.

3. Follow fertilizer recommendations.

4. Do not begin grazing until the plants have reached the proper height. Prussic acid is present in appreciable amounts only in the rapidly growing part of the plant, which is a very small portion of a sudangrass plant 18 to 20 inches or more in height and a sorghum-sudangrass plant 24 to 30 inches or more in height. The same is true of new growth following a frost that kills the tops but not the crowns of the plants, and the new growth brought about by rains following a drought.

5. Feed hay to hungry livestock before turning them into sudangrass or sorghum-sudangrass hybrids for the first time. It might also be helpful to permit grazing for only a short period of time the first day. Livestock turned into a field of sudangrass or sorghum-sudangrass that is high in prussic acid usually will stop eating in 10 to 15 minutes if they are not too hungry. Livestock vary in the amount of prussic acid that it takes to be fatal. If they are in a low state of vigor and/or very hungry, they are more likely to eat a fatal dose than if they are vigorous and not hungry.

6. Frosted sudangrass and sorghum-sudangrass hybrids can be very dangerous if pastured before the plants have thoroughly dried. Immediately after frost, remove the animals from the pasture until the grass has dried out, usually 5 to 6 days. If new shoots develop after a frost, use the forage as hay or silage rather than pasture. Frosted sudangrass and sorghum-sudangrass hybrids can be safely used for hay or wilted silage.

7. Use tester animals if you are going to feed questionable hay, when there is reason to question the safety of grazing or green feeding, or when the silo or bunker is freshly opened. Instead of risking the whole herd, place one or two of the least valuable animals into the pasture before turning in the whole herd. Leave the tester animals in the pasture for several hours in order to test the forage for poisonous properties. Do the same with questionable hay or silage. Begin by testing the feed with one or two animals.

8. If you suspect poisoning trouble, call your veterinarian promptly. Immediately remove animals from the feed.

Causes and Prevention: Prussic Acid Poisoning of Livestock

by

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