

Preventing Prussic Acid Poisoning of Livestock

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Sudangrass and sorghum are two of a group of plants that produce cyanide, which can poison livestock under certain conditions. These plants, called cyanogenic plants, produce cyanogenic glucosides during their growing stage. Glucosides are compounds that break down or decompose into glucose sugars by hydrolysis—addition of water. In cyanogenic plants this decomposition process 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 glucosides are not within themselves poisonous, but when certain enzymes

are present, they are highly toxic to both man and animal. The enzymes involved in the hydrolysis, or chemical decomposition, are usually present in the same plant—but may be available from other sources. Digestive juices may cause the hydrolysis to occur.

Under normal growing conditions, the intact glucoside occurs in the plant. When plants containing such glucosides are eaten by animals, they are readily eliminated before enough concentration occurs to be harmful. However, certain conditions involving climate, fertility, stage of growth, and anything that retards plant growth and development may increase cyanogenic glucosides in the plants. A rapid regrowth following retardation favors the increase of glucosides. Wilting and frost injury may cause rapid increase of hydrocyanic acid (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, it 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 fed with safety. Prussic acid is released very quickly from the glucoside form in frozen leaves, and hence frosted sorghum is very dangerous until it begins to dry out.

Usually there is little danger of prussic acid poisoning in grazing most varieties of sudangrass. 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, sudangrass will send forth new shoots and leaves which are apt to be very high in prussic acid and, if pastured, cause prussic acid (cyanide) poisoning.



Effect of Prussic Acid on Animals

Young plants and leaves of sudangrass and sorghum contain the cyanogenetic glucoside *dhurrin* (or *durrin*). Also present in these young plants and leaves is an enzyme called *emulsin*, which breaks down some of the harmless glucoside *dhurrin* to release the poison known as "prussic acid" or "hydrocyanic acid" (HCN). If plants are damaged, as 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 fed plants containing these glucosides. 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 cyanogenetic glucosides. 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. An excellent medium is thus provided for the hydrolysis of the glucoside with the liberation of the toxic agent—hydrocyanic acid—which is then rapidly absorbed into the blood. Horses and hogs, being non-ruminants, have only one stomach which is strongly acid 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 toxicifying action of HCN is almost immediate; that is, as soon as it is liberated from the glucosides. The specific action of HCN on animals is that it combines with hemoglobin to form cyanoglobin, which does not carry oxygen. Thus animal tissues are deprived of necessary 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. The clinical signs are seldom seen because most HCN-poisoned animals die within a matter of minutes once the toxic agent gets into the blood stream, usually within 15 to 20 minutes after animals consume the forage. It has been shown by various investigators that it 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 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 as 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.*

Influence of Cultural Practices and Environment on 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.

- a. It makes possible and speeds up the formation of certain proteins which use up nitrogen that might otherwise accumulate in the form of cyanide.
- b. It 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. 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 and sorghum 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. However, the hazards associated with poisoning decrease only slightly with age if animals selectively graze the more tender new growth—those plant parts high in prussic acid.

Sudangrass should not be grazed until it has reached a height of at least 18 inches. Short (3 to 4 inches), dark green sudangrass may contain well in

* 0-25 mg/100 g = 0.250 ppm = 0.025%
50-75 mg/100 g = 500-750 ppm = 0.050-0.075%
100 mg/100 g = 1,000 ppm = 0.1%

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 the plants have attained a height of about 18 to 24 inches, HCN content should be at a level less than 50 mg HCN/100 g dry tissue and be safe to pasture.

Species and variety

Sorghums are generally much higher in prussic acid than sudangrass. As a group, sorghum-sudan-grass hybrids also contain more prussic acid than sudangrasses. Some varieties, such as Piper and Trudan sudangrasses, tend to be lower in prussic acid than others. Growers should select varieties that tend to be lower in prussic acid potential.

Frost

Prussic acid is released very quickly from the gluco side form in frozen leaves, and hence frosted sudangrass can be very dangerous until it has dried out. The free prussic acid in this forage does not begin to decline until thawing and wilting begin. The forage is usually 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, sudangrass 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 sudangrass that caused the poisoning rather than the new growth.

Drought

When, due to drought, water is withheld from sudangrass which is less than 18 inches in height, a high prussic acid content may persist because the grass is unable to grow out of the high prussic acid stage. Thus drought probably operates as a factor largely by keeping the plants small, in which stage they are generally higher in HCN content than when larger. Drought not only keeps the plants small by withholding water, but probably also reduces the availability of phosphates to plants. Thus the drought conditions may be compounded by the high nitrogen-low phosphorus situation mentioned above.

Utilizing Potentially Hazardous Forages

Pasture

Deaths on pasture are partially caused 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. The forage will generally be safe to feed after drying 5 to 6 days. Frosted foliage contains very little prussic acid after it is dry.

If new shoots develop after a frost, the crop should not be grazed until the new growth is at least 18 inches tall. This may mean that the crop is harvested as hay or silage since, in most cases, 18 inches of growth cannot be obtained after frost occurs.

Heavy stocking rates—4 to 6 animal units per acre—and rotational grazing help to reduce the hazard of prussic acid poisoning on pasture.

Green chop

Green chop forage is usually 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 the leaves.

Wilted silage

Silage is generally 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 hay decreases by as much as 75 per cent while curing and is rarely hazardous when fed to livestock.

Proper Grazing Management of Sudangrass and Sorghum-Sudangrass Hybrids

The following program of sudangrass (or sorghum-sudangrass) management is recommended. This management program not only minimizes the danger of prussic acid poisoning, but also provides the most pasture from a given area.

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

Rotational grazing of sudangrass has other notable advantages. It makes possible the production of more pasture 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 manufacture takes place; if these leaves are grazed off as soon as formed, the grass does not have the advantage of a period when rapid manufacture of carbohydrates and proteins, and hence rapid growth, can take place. In rotational grazing, the sudangrass has the advantage of rapid growth that comes only after a good start is once made.

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

As stated previously, to obtain the most forage, low in prussic acid, sudangrass should not be grazed until it is at least 18 inches tall. When the acreage is divided into two or more areas, grazing of a smaller area at a time is made possible. This forces the livestock to remove quite completely and uniformly, in a relatively short period, the growth which has accumulated. The proportionately small amount of new growth which is 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 photosynthesis and growth. When the regrowth in this first area has reached a height of 18 inches or more, the field is again ready for grazing. Other areas are managed similarly. If other pasture than sudangrass is available, livestock may, of course, be rotated from sudangrass to other pasture and back again.

Summary

Usually there is little danger of prussic acid poisoning in grazing most varieties of sudangrass. However, the young growth that follows clipping, drought, frost, or grazing may contain appreciable quantities of prussic acid. The following precautions are therefore recommended.

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 are at least 18 inches in 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 plant 18 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. If there is reason to question the safety with which sudangrass can be grazed or fed green, the use of tester animals is advised. Instead of risking the whole herd, place one or two of the least valuable animals into the pasture before turning in all the livestock. Leave the tester animals in the pasture for several hours in order to test the forage for poisonous properties.
5. Feed hay to hungry livestock before turning them into sudangrass 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 which is high in prussic acid will usually 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 very hungry, they are more likely to eat a fatal dose than if they are in good vigor and not hungry.
6. Frosted sudangrass 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, utilize the sudangrass as hay or silage rather than pasture. Frosted sudangrass can be safely utilized for hay or wilted silage. Use tester animals when turning into a questionable pasture, using questionable hay, or when the silo or bunker is freshly opened.
7. If you suspect poisoning trouble, call your veterinarian promptly. Remove animals from the feed. Don't delay—time is of the essence.



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