

MU Guide

Warm-Season Annual Forage Crops

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Annual warm-season grasses can be used as part of a year-round grazing system throughout Missouri. With adequate moisture and fertility, they rapidly produce high-quality forage during late spring and summer when cool-season forages are dormant. In addition, warm-season annual grasses work well in rotation with row crops or as emergency pastures. Although many annual crops are used for summer grazing, pearl millet (*Pennisetum americanum*), sorghum-sudangrass (*Sorghum bicolor*) hybrids, and crabgrass (*Digitaria sanguinalis*) are the most common. Hay-feeding trials at the Southwest Center of the Missouri Agricultural Experiment Station indicate that properly supplemented animals could gain 1.6 to 1.8 pounds per day on sorghum-sudangrass and pearl millet. Similar data have been reported for crabgrass.

Sudangrass and sorghum-sudangrass hybrids

True sudangrasses have been used extensively in the past, but their use has declined with the development of sorghum-sudangrass hybrids. Sorghum-sudangrass is a hybrid developed by crossing forage sorghum with true sudangrass. Forage sorghums are often tall-growing and stemmy. They should not to be confused with milo, which was developed by selecting for short stalks with large heads and a high harvest index. Forage sorghum was crossed with sudangrass to increase leafiness and forage production while minimizing seed set.

There is little difference in yield among sudangrass or sorghum-sudangrass cultivars, and most variation in yield can be attributed to differences in moisture availability. Piper is the most widely used cultivar largely because it is reported to have less prussic acid than other cultivars. Several other proprietary hybrids perform well, so seed cost and availability should be strongly considered when selecting varieties.

Sorghum-sudangrass is intolerant of low soil pH and should be planted only on land with a soil pH above 5.5. It should be seeded during May at 30 to 35 pounds per acre when broadcast onto a prepared seedbed or 20



Sorghum-sudangrass seed head (left) and shoot (right).

Sorghum-sudangrass at a glance

Common names: Sudangrass, sorghum-sudangrass, forage sorghum

Origin: Northeastern Africa

Adaptation to Missouri: Statewide

Growth habit: Tall, upright

Tolerance to drought: Good

Tolerance to poor drainage: Good

Cultivars: Several proprietary hybrids and brown midrib types are available — see your seed dealer for options

Ease of establishment: Easy

Seeding rates: 20–25 lb/acre drilled; 30–35 lb/acre broadcast

Seeding dates: May 1 to June 30

Preferred seeding depth: ½ to 1 inch

Days from seeding to first grazing: 45–60

Preferred soil pH: 5.5 or higher

Fertilization: 60–90 lb of N/acre at establishment. Apply 40–60 lb of N after each cutting or grazing thereafter. P and K to soil test.

Timing of production: 90% of production occurs in June, July and August

When to begin grazing: When it reaches 24 inches (Note: To avoid prussic acid poisoning, do not graze when it is shorter than 24 inches. It is also best to delay grazing for 14 days after frost or drought stress.)

When to cut for hay: When it reaches 30–36 inches

Lowest cutting or grazing height: 10 inches

Suitability for wildlife cover: Poor

to 25 pounds per acre when drilled in 7- to 15-inch rows. No-till establishment works well if weed and sod competition are controlled with a burndown herbicide at seeding.

Pearlmillet

Pearlmillet is an excellent choice for warm-season pasture because it tolerates acidic soils and drought. Unlike sorghum-sudangrass, it does not contain prussic acid. Other millets, such as proso, foxtail or German, are



Pearlmillet makes a high-quality, warm-season forage.

Pearlmillet at a glance

Common name: Pearlmillet
Origin: North-central Africa
Adaptation to Missouri: Statewide
Growth habit: Tall, upright, tillering
Tolerance to drought: Excellent
Tolerance to poor drainage: Good
Cultivars: Tifleaf I, Tifleaf II, Mil-Hy-300, Sunny State, Tifleaf III, PP102M
Ease of establishment: Easy
Seeding rates: 15 lb/acre drilled; 20–30 lb/acre broadcast
Seeding dates: May 1 to June 15
Preferred seeding depth: ¾ to 1 inch
Days from seeding to first grazing: 45–60
Preferred soil pH: Higher than 5.0
Fertilization: 60–90 lb of N/acre at establishment. Apply 40–60 lb of N after each cutting or grazing thereafter. P and K to soil test.
Timing of production: 90% of production occurs in June, July and August
When to begin grazing: When it reaches 18–30 inches
When to cut for hay: When it reaches 36 inches
Lowest cutting or grazing height: 8 inches
Suitability for wildlife cover: Poor

often used in silage or hay mixtures. However, they produce less forage and have a shorter grazing season than pearl millet.

Pearlmillet is typically drilled at 15 pounds per acre or broadcast into a prepared seedbed at 20 to 30 pounds per acre from May 1 through the middle of June. The major factor limiting the time of establishment after mid-June is the availability of moisture. Therefore, seeding before the beginning of summer is recommended because of the decreasing probability of rainfall as summer progresses.

Widely available cultivars include Tifleaf I, Tifleaf II, Mil-Hy-300 and Sunny State. Like sorghum-sudangrass cultivars, pearl millet cultivars show little difference in yield. Therefore, cultivars should be selected on the basis of seed price and availability.

Crabgrass

Although commonly considered a weed in row crops, crabgrass provides high-quality summer forage and grazing. It is gaining popularity because it can be used alone, double-cropped behind winter annual pastures, or used in combination with perennial cool-season grasses. Like pearl millet, crabgrass does not contain prussic acid.

Productivity of crabgrass is determined by the availability of moisture. When planted as a single crop with good growing conditions and adequate moisture, crabgrass can yield 4,000 to 8,000 pounds of dry matter per acre. The improved cultivar Red River has yielded 8,000 to 10,000 pounds of dry matter per acre under optimum growing conditions.

Although many stands of crabgrass are natural ecotypes, improved cultivars can be established by seeding 3 to 4 pounds of seed per acre in April. Crabgrass seed can be broadcast with fertilizer and then lightly harrowed. Remember that the seed are small and light and will not broadcast farther than 25 feet from most fan-type spreaders. Crabgrass can also be established using a no-till drill, but because the seed are small, they should not be planted deeper than ¼ inch.

Managed properly, this annual grass can persist as a perennial through natural reseeding. To ensure natural reseeding, livestock should be removed at least 3 weeks before the first killing frost to allow seed to set. The following spring, the ground should be lightly scratched with a disk or harrow in late April or early May to provide adequate soil-seed contact. An application of 40 pounds of nitrogen per acre will speed development of a stand.

Animals perform best on crabgrass pasture if it is grazed rotationally. This allows the producer to keep the forage in a high-quality, vegetative growth stage. Ideally, it should be grazed before it reaches a height of 8–10 inches and not grazed to less than 3 inches. Beef cattle have gained up to 2.25 pounds per day on good crabgrass pasture and have repeatedly gained 0.2 pound per day more on crabgrass than on bermudagrass.



Crabgrass shoots, including root system.

Crabgrass at a glance

Common name: Crabgrass
Origin: Southern Africa
Adaptation to Missouri: Statewide
Growth habit: Sod forming
Tolerance to drought: Fair
Tolerance to poor drainage: Poor
Cultivars: Red River, Common
Ease of establishment: Easy
Seeding rates: 3–4 lb/acre
Seeding dates: May 1 to May 31; can be overseeded into winter annual grasses from late winter to early spring
Preferred seeding depth: ¼ to ½ inch
Days from seeding to first grazing: 30–45
Preferred soil pH: 5.5 or higher
Fertilization: 40 lb of N/acre at establishment. Apply 60 lb of N after first cutting or grazing. P and K to soil test.
Timing of production: 80% between mid-June and August
When to begin grazing: Before it reaches 8–10 inches
When to cut for hay: Boot stage, approximately 10–12 inches
Lowest cutting or grazing height: 3 inches
Suitability for wildlife cover: Poor

Harvest management

Hay curing is difficult with either pearl millet or sorghum-sudangrass because of large stem size. It is imperative that a mower-conditioner be used to crush the stems to speed drying.

Sorghum-sudangrass can produce 4 to 8 tons of forage per acre when harvested to a 6- to 10-inch stubble. It should be harvested each time the accumulated growth reaches a height of 24 to 36 inches. Maximum yield of sorghum-sudangrass is obtained if stubble

height is maintained at 10 inches to allow for regrowth to originate from terminal buds rather than from buds at the base of the plant.

Allowing forage to accumulate above 24 inches will result in stemmy, lower-quality forage. The crude protein content of these grasses falls rapidly after they reach a height of 36 inches and heads begin to emerge. Crude protein content can easily be reduced from 12–14 percent in the vegetative growth stages to 6–7 percent when the grasses reach the dough stage. Digestibility follows a similar pattern; it will be higher for new cultivars that express a brown midrib trait. The brown midrib indicates low concentration of lignin, which is a part of the fiber that is not digested well.

Harvest management for pearl millet is much the same as for sorghum-sudangrass, except that pearl millet is more dependent on terminal buds for regrowth. For this reason, pearl millet should be cut at a higher stubble height (8 to 12 inches) than sorghum-sudangrasses to ensure maximum yields. Pearl millet regrows slower than sorghum-sudangrass, and the rate of regrowth can be greatly reduced by cool weather.



Sorghum sudangrass taller than 36 inches produces stemmy, low-quality forage.

Key harvest suggestions include the following:

- Do not attempt to make hay without using a mower-conditioner.
- It is impossible to overcrush sorghum-sudangrass and pearl millet stems.
- Use more roller pressure than is used on other hay crops and drive in low gear.
- Do not windrow until all plants on the top of the swath are dry enough to bale (15 to 18 percent moisture).

Because of difficulties with hay curing, grazing is the best way to make use of these highly productive forage crops. Grazing trials conducted at the Southwest Missouri Center in the late 1960s and early 1970s indicated that these forages can support average daily gains (ADG) of 1.4 to 1.7 pounds per day over a 90-day grazing season from June through August.

Soil fertility

Soils should be tested before establishing pearl millet and sorghum-sudangrass; phosphorus and potassium should be applied according to test recommendations before planting. These forages respond well to nitrogen and should receive 60 to 90 pounds of nitrogen per acre at establishment.

Both sorghum-sudangrass and pearl millet have shown yield responses up to 400 pounds of nitrogen per acre. Sorghum-sudangrass tends to yield more than pearl millet at the same nitrogen rate. Best results are obtained by splitting nitrogen applications such that part of the nitrogen is applied when the crop is established and another 40 to 60 pounds per acre are applied after the first grazing. Split application improves the efficiency of using nitrogen fertilizer, provides more even forage production, and reduces the potential for nitrate toxicity due to overfertilization. Care must be taken with these forages to avoid nitrate toxicity. Excessive nitrogen fertilization is the key cause of nitrate toxicity.

Crabgrass also responds well to high rates of nitrogen application. Studies show that crabgrass responds to nitrogen rates as high as 200 pounds per acre, but most producers apply 70 to 100 pounds per acre per year for maximum economic returns. Nitrogen applications should be split — half when plants begin to grow in May and the rest in early July.

Livestock toxicities

Nitrate toxicity

Heavy nitrogen fertilization followed by drought is the most common situation that causes nitrate accumulation in forage. Shading and cool, cloudy weather can also contribute to this problem. These environmental conditions result in nitrate accumulation because growth is limited while nitrate uptake continues. In cattle, nitrates are reduced to nitrite in the rumen. Nitrites are toxic to livestock because they interfere with the ability of blood to carry oxygen.

The rate of nitrate incorporation in plants is regulated by the nitrate reductase enzyme. Molybdenum is

a key part of nitrate reductase. If plants are deficient in molybdenum, nitrate reduction is inhibited, potentially resulting in nitrate toxicity. The availability of molybdenum to plants is determined by soil acidity. Liming to desirable pH levels of 5.5 to 6.0 is usually sufficient to overcome molybdenum deficiency and alleviate this potential cause of nitrate toxicity. Nitrates are typically concentrated in the lower portion of the stem, so care should be taken to keep animals from consuming large amounts of the lower part of the stalk of these forages when nitrate concentrations may be high.

If plants contain more than 1.5 percent nitrate (15,000 parts per million), they should be considered toxic to livestock. Nitrates will persist in harvested hay since they do not break down during the curing process. If nitrate accumulation is suspected, forage should be tested before feeding. Pregnant and young animals are particularly sensitive to nitrate toxicity. Care should be taken when feeding forages containing greater than 0.25 percent nitrate (2,500 ppm) as a percentage of dry matter to these animals. Forages containing 0.25 to 0.5 percent of dry matter as nitrate should make up no more than half of the total ration (see Table 1). Forages with 0.5 to 1.5 percent nitrate should make up no more than one-fourth of the total ration, and livestock should receive supplemental energy, minerals and vitamin A.

Prussic acid poisoning in sorghum-sudangrass

A potential problem with sorghum-sudangrass is prussic acid, or cyanide poisoning. When sorghum-sudangrass plants are injured or under stress, enzymes that convert glycosides to sugar and prussic acid are released. Levels of cyanide greater than 2 mg/kg (2 ppm) of dry plant tissue are considered potentially dangerous. Prussic acid is readily absorbed into the bloodstream and causes toxicity by blocking normal cellular respiration in the animal.

The environmental conditions that favor toxic levels of prussic acid are drought stress and frost damage. If sorghum-sudangrass is under drought stress, avoid grazing until the plants have recovered and exhibit at least 24 inches of regrowth. Following a severe frost,

Table 1. Warning levels for forage nitrate content

| Nitrate concentration | | Forage status | Comments |
|-----------------------|-----------------|---------------|--|
| % | ppm | | |
| 0 to 0.25 | 0 to 2,500 | SAFE | Forage is generally safe to feed at these levels to all classes of livestock. |
| 0.25 to 0.50 | 2,500 to 5,000 | CAUTION | Forage with this nitrate (NO ₃) content can cause a problem with pregnant and young animals. Do not feed forage with nitrate levels this high in combination with nonprotein nitrogen supplements, and limit forage with NO ₃ levels this high to one-half of total ration. |
| 0.50 to 1.5 | 5,000 to 15,000 | DANGER | Limit forage with this NO ₃ level to one-fourth of total ration. Should supplement forage of this type with energy, minerals and vitamin A. |
| Over 1.5 | Over 15,000 | TOXIC | Forage with this NO ₃ level or higher is toxic and should not be fed under any circumstance. If forage with this NO ₃ concentration must be fed, it should be mixed with other feed and make up no more than 15 percent of the total ration. |

avoid grazing sorghum-sudangrass for 14 days or until the leaves turn brown, whichever is longer.

In addition, prussic acid levels are highest in young, leafy tissue, whether it is initial growth after planting or regrowth after clipping. Since it is the young, fast-growing tissue that contains dangerous levels of prussic acid, avoid grazing until the plant reaches a height of at least 24 inches to allow prussic acid to dissipate. Unlike nitrates, which are persistent, prussic acid disappears during the hay curing or ensiling process.

Prussic acid can be detected through the use of

picrate strips. Filter paper that has been treated with a solution of picric acid and allowed to dry is suspended in a test tube over a sample of plant material that has been treated with a few drops of chloroform. The test tube is then incubated for several hours. If prussic acid is present, the yellow sodium picrate paper will turn increasingly red in direct proportion to prussic acid concentration.

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Key points in management of warm-season annual grasses

- Warm-season annuals should be seeded when soil temperatures reach 55 to 60 degrees F in late spring while available moisture is still high.
- Before the crop is established, phosphorus and potassium fertilizer should be applied according to soil test recommendations.
- Pearlmillet should be used in preference to sorghum-sudangrass on droughty or more acidic sites.
- For sorghum-sudangrass and pearlmillet, nitrogen should be applied at 60 to 90 pounds per acre at establishment with additional applications of 40 to 60 pounds of nitrogen per acre after each grazing or harvest to obtain maximum yields.
- For crabgrass, nitrogen should be applied at 70 to 100 pounds per acre per year for maximum economic returns. Nitrogen applications should be split by applying half at green-up in May and the rest in early July.
- Sorghum-sudangrass and pearlmillet should be harvested each time growth accumulates to a height of 24 to 36 inches, leaving 10 inches of stubble for regrowth.
- Crabgrass should be grazed before it reaches a height of 8 to 10 inches, leaving 3 inches of stubble for regrowth.
- When grazed, annual grasses are best used with a rotational grazing scheme that leaves sufficient stubble and allows adequate rest between grazing periods to support regrowth.
- Forage should not be harvested or grazed following prolonged periods of drought or cloudy weather, particularly when heavily fertilized with nitrogen, without prior testing for nitrate content. Forage containing more than 1.5 percent nitrate should not be fed. Consumption of forages containing greater than 0.5 percent, or 5,000 ppm, nitrate should be limited to no more than one-fourth of the ration.
- After frost damage or drought stress, sorghum-sudangrass should not be grazed for 14 days or until there is 24 inches of regrowth. This helps to avoid prussic acid poisoning. Prussic acid dissipates during hay curing or ensiling, so forage harvested at the proper height or stored 10 to 14 days should not present a problem.

