

Warm-season annual grasses, specifically sorghums (*Sorghum* spp.), have the potential to produce large amounts of nutritious forage during summer months, and their versatility allows them to fit into many different types of cropping or livestock operations. These grasses may be particularly useful in regions with high concentrations of beef and dairy cattle, such as the Texas panhandle and eastern New Mexico. They fit well into dryland and limited irrigation situations because of their tolerance to drought, and it is in these systems that the grasses may have the greatest potential.

In areas of year-round livestock grazing, sorghums can provide nutritious forage during hot, dry summer months when cool-season perennial grasses have gone dormant and warm-season perennial pastures are lacking nutrition (Fribourg, 1995). If managed properly, they make excellent hay for supplemental feeding during times of inadequate forage production. Another advantage of sorghums is that they can be used as an emergency, late-planted crop to replace a primary crop that has been damaged by wind, hail, or drought early in the growing season. As a cover crop, they do an excellent job of suppressing weeds and improving soil quality, organic matter, and nitrogen status (Sattell et al., 1998). Perhaps the greatest advantage of sorghums is the diversity of management options that the grower can choose from in order to match the plants with production needs. Depending on which species or varieties are selected, the grasses may be used for grazing pasture, hay production, and silage and green-chop operations. The ability of some varieties to tiller and regrow after cutting or defoliation makes them ideal for multiple cut or grazing situations. Whatever the enterprise, it is likely that

most growers can utilize these summer annuals to their advantage in some form or another.

## **SORGHUM [*Sorghum bicolor* (L.) Moench]**

The sorghum species that are predominantly used for forage or feeding purposes fall into three main categories: forage sorghums, sudangrasses, and sorghum-sudangrass hybrids. These sorghums have little value as directly marketable seed crops, but their value becomes apparent when they are marketed for livestock and industrial utilization (e.g., milk, meat, and ethanol; Pederson and Fritz, 2000).

In general, sorghums are coarse, erect grasses that vary in height from 2 to over 15 feet. The majority of growth occurs in July and August, but persists until maturity or fall frost. Growth increases with long days and warm temperatures, with 77 to 86°F being the most favorable temperature range. Most have the ability to tiller to at least some extent and will fill into open spaces between rows or other plants. Sorghums can tolerate significant moisture stress and will resume vegetative growth after drought-induced dormancy (Fribourg, 1995). This characteristic makes them desirable for use in situations with inconsistent or very intermittent watering and dryland operations. Leaves are similar to those of corn (*Zea mays* L.), but often have less leaf area because blades are shorter. Inflorescences are arranged primarily in erect panicles and yield from 11,000 to 70,000 seeds per pound, depending on sorghum type (i.e., grain or forage type). Sorghums have been grown successfully in all parts of the state and do particularly well in dry regions under irrigation.

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## FORAGE SORGHUM (SILAGE PRODUCTION)

Forage sorghums, sometimes called “cane,” “sweet sorghum,” or “sorgo,” have the potential to grow very tall (6 to 15 feet) and can produce large amounts of vegetative growth. Grain sorghum, in contrast, is shorter in stature and produces higher proportions of seed for grain marketing purposes. In general, grain types have compact panicles with larger seeds, while forage sorghums have more open panicles and contain fewer and smaller seeds. Forage sorghum stems are usually thick and are characterized by either sweet or insipid juice.

It has been documented that forage sorghums have the potential to produce as much, and in some cases more, dry matter than corn when grown with the same amount of water (Anderson and Guyer, 1986; Marsalis et al., 2009b; Teutsch, 2002). In general, sorghums are more water-use efficient than corn (Martin et al., 1976), particularly in limited irrigated situations (Marsalis et al., 2009b). Even in situations where corn and sorghum water-use efficiencies are similar, corn tends to use more water because of earlier planting dates and longer growing seasons (Howell et al., 1997). In addition to the advantage of a later planting date, forage sorghums have the ability to maintain high yields under water stress conditions and resume growth after drought (Marsalis et al., 2009a, 2009b; Sanderson et al., 1992).

Most forage sorghums are grown for single-cut silage or green-chop operations because of the achievable high tonnage and poor regrowth after cutting. Drying forage sorghums for hay can be particularly difficult due to the grasses’ large stems. Inadequate regrowth after grazing limits productivity in both continuous and rotational stocking systems. Also, forage sorghums often contain more toxic substances (see **Toxicity Concerns** section) than other summer annual grasses, and grazing could be potentially harmful to livestock (Anderson and Guyer, 1986).

### Fertilization

Fertilization of forage sorghum should be similar to that of corn grown for silage. Although sorghums will grow on infertile soils, they respond well to increased fertility. Growth is optimized at pH levels of 6.0 to 7.0 on well-drained soils; however, they have produced well on the higher

pH soils commonly found in New Mexico. Regional observations indicate that sorghums in general do not perform well on sandy soils that are shallow and high in calcium carbonate (e.g., caliche soils). Plants on these soils are often chlorotic (iron- and/or zinc-deficient) and low-yielding.

Fertilizer inputs should always be based on soil test results for a given field and will vary from one situation to the next. In the absence of a soil test, general recommendations for phosphorus (P) and potassium (K) are 30 to 80 lb/ac of each at planting; however, yield responses to these fertilizers may be minimal if soil levels of P and K are medium or higher.

Phosphorus is often limiting, particularly in highly calcareous soils where levels of available P are low. Soil tests indicating P levels lower than 20 ppm (Olsen P) will likely require a P fertilizer application. The general P recommendation for forage sorghum is 2.75 to 3.25 lb P<sub>2</sub>O<sub>5</sub>/ac for every ton of expected yield.

New Mexico soils are often adequate in K, and rarely is any benefit of adding K reported. However, silage crops tend to extract large amounts of nutrients, including K; therefore, the likelihood of encountering a K deficiency is increased in high production silage systems grown year after year.

Zinc (Zn), especially in crops such as sorghum and corn, can be deficient, and applications of 5 to 8 lb Zn/ac are often recommended if soil tests indicate a “low” (<0.5 ppm DTPA) condition.

Nitrogen (N) requirements depend on expected yield and, for high-yielding varieties, may be as high as 200 lb N/ac under irrigated conditions and as low as 15 lb N/ac in dryland situations. A general rule of thumb is that 8 to 9 lb N will be used for every ton (wet) of silage produced; however, excellent yields have been obtained with as little as 6.5 lb N/ac per ton of expected yield. Dryland N requirements will be lower than those necessary for irrigated fields due to lower plant populations and lower expected yield (Mortvedt et al., 1996). Nitrogen inputs from previous crops and inputs (e.g., legumes, manure) should be factored into fertilizer calculations. At high rates, N applications should be split for uniform utilization of the fertilizer. Forage sorghums will remove large amounts of nutrients from the soil, so it is imperative that producers test their soils frequently in order to accurately assess their fertilizer needs.

**Table 1. Generalized Seeding Rates for Various Types of Sorghum Forages in Irrigated and Dryland Conditions and at Different Row Spacings**

Forage Type	Seeds per lb†	Dryland		Irrigated	
		Row Spacing (inches)			
		6-20	20 or more	6-20	20 or more
		lb/ac			
Forage Sorghum (conventional)	16,000	—	3-5	15-20	5-8
Forage Sorghum (Brown Midrib)	16,000	10-15	3-7	10-15	5-7
Sorghum-Sudangrass Hybrid	16,000-17,000	10-15	5-8	15-20	5-10
Photoperiod Sensitive	16,000	15	10	25	10-15

†Assumed average seeds per lb. Seed size varies greatly among sorghum types and varieties, leading to high variability in seeds/ac when using a standard lb/ac seeding rate.

Adapted from: Butler and Bean (n.d.). Rates based on observations and studies conducted in the Southern High Plains.

### Establishment

Although forage sorghums can be broadcast or drilled, most are planted in rows in a fashion similar to corn for ease of harvesting with silage equipment and for weed control (e.g., directed spraying or cultivation). Like most crops, a well-prepared, firm seedbed is necessary for proper seed-soil contact and subsequent good germination and establishment. Plantings into July can result in high yields, even in more northern regions of New Mexico, and may allow for more flexibility in double cropping systems. However, early plantings can result in non-uniform and poor stands because of low soil temperatures. A minimum soil temperature of 60°F for 5 to 10 days is required for proper germination, and sorghums are less tolerant of cool temperatures than corn. Planting depths of 3/4 to 1 1/2 inches are desirable; planting deeper may lead to poor seedling emergence.

Seeding rates will vary depending upon intended use, row spacing, seed size, and irrigation (Table 1). With forage type sorghums, there is a broad range of the number of seeds in a pound. Most forage sorghums range between 12,000 and 22,000 seeds/lb. Hence, it is better to use number of seeds per acre for estimating planting rates rather than using number of pounds per acre.

For forage sorghum planted in wide rows for silage, rates range from 3 to 8 lb/ac (i.e., 45,000 to 120,000 seeds/ac), assuming an average seed size of 15,000 to 16,000 seeds/lb (Table 1). In areas of eastern New Mexico and the Texas panhandle, excellent yields have been obtained from plantings with rates as low as 6 lb/ac under irrigation. If

heavier rates are used with wide rows, competition among plants within a row will result in fewer established plants overall. In contrast, if lower rates are used, individual plants will tiller more extensively and will fill in the spaces within and between rows better. Many growers underestimate the ability of these forages to compensate for low seeding rates and poor establishment, and will unnecessarily increase their production costs by planting at higher rates. Tillering, stem size, and leaf size at what seems to be somewhat lower plant populations can do an adequate job of compensating for gaps in the stand (even if due to poor emergence). If irrigation is limited, seeding rates should be reduced. Dryland seeding rates range from 1/2 to 2/3 of those for irrigated plots. Increasing seeding rate does not always result in higher yields, and excessive rates escalate the risk of potential lodging of plants. Although forage sorghums are not the most desirable for growing hay, if used for this purpose, seeding rates should be high in order to decrease stem size and drying time. For example, narrow row drilled spacing (e.g., drill rows 6 to 20 inches apart) rates may be as high as 20 lb/ac (Table 1). Some varieties may have specific seeding recommendations provided by the marketing company that are based on tests or experience in your area and should help in making seeding rate decisions.

### Weed Control

Controlling weeds is perhaps the most significant management issue in growing forage sorghum. Weeds compete with forage sorghum for light, nutrients, and soil moisture and can harbor insects,

diseases, and toxic substances that affect yield and quality. It is critical that weeds be controlled prior to planting. Weeds left uncontrolled during any fallow period will use up valuable soil moisture that could be stored for later use by the crop. Control weeds either by tillage or with herbicide application. If a residual herbicide is used, check the label to determine if there are any restrictions to planting sorghum following the application. During the fallow period, atrazine and glyphosate can be good choices for weed control. However, keep in mind that some weeds have developed resistance to atrazine.

Once forage sorghum is planted, few herbicide options are available. Yield losses will be greatest when weeds emerge with the crop or soon after. The most critical period for weed control is the first 4 weeks after planting. Yield reduction from weeds that emerge 4 weeks after planting is usually minimal. Ensuring a good stand at crop emergence and rapid canopy closure goes a long way toward giving the sorghum a competitive edge against weeds. Annual grasses are more difficult to control than broadleaf weeds once sorghum is emerged.

## Herbicide Options

### Pre-Emergence Weed Control

Currently, only two herbicide active ingredients are labeled for pre-emergence use in forage sorghum, atrazine and metolachlor (or *s*-metolachlor), and they are sold either alone or in combination with each other. Atrazine will control many annual broadleaf weeds and is relatively inexpensive. Restrictions and rates of atrazine use vary considerably depending on state/local requirements. Closely examine the label before using in any particular field. Generally, atrazine should only be applied prior to sorghum emergence in medium- or fine-textured soils at reduced rates or crop injury can occur.

For pre-emergence grass control, metolachlor is a good option since it will control many annual grasses. If the grass population is very high, some escapes may occur, but metolachlor is currently the only pre-emergent herbicide available for grass control in forage sorghum. The effectiveness of control will depend on the specific grass species as well as other factors.

When using metolachlor at planting, sorghum seed must be treated with Concep safener to avoid

significant crop injury. It is important to find out if the forage sorghum is capable of being treated with Concep, and if so, treatment is recommended. Although this will add to the seed cost, it is well worth it to control grasses at planting. However, the financial risk of Concep-treated seed and subsequent use of metolachlor is greater in non-irrigated situations where the benefit of herbicides is questionable if rainfall is not sufficient for proper incorporation. Both atrazine and metolachlor require a minimum of 0.5 inch of rain or irrigation water to move into the soil to effectively control germinating grass seed. An alternative to rain or irrigation is to incorporate the herbicides with a rolling cultivator prior to grass emergence. However, care must be taken to avoid damaging the forage sorghum.

### Post-Emergence Weed Control

Although more herbicides are available for post-emergence control of broadleaf weeds compared to pre-emergence, options are still limited. Atrazine can be applied post-emergence and is effective on small weeds, and remains in the soil to provide residual control of later weed flushes. If applied post-emergence, atrazine should always be applied with crop oil before the sorghum reaches 12 inches in height. **The smaller the weeds, the better the control will be.** Other herbicides available are 2,4-D, dicamba, fluroxypyr, carfentrazone, and bromoxynil. All of these can be used in combination with each other or with atrazine. Dicamba and 2,4-D must be applied correctly or severe crop injury can occur. These should only be applied to sorghum that has not exceeded 8 inches in height. Drop nozzles that keep the herbicides out of the whorl of the sorghum can be used on sorghum up to 15 inches tall. Care should be taken to minimize drift of 2,4-D and dicamba or damage to other broadleaf crops (e.g., cotton) and ornamentals can occur. Check label for rates, application timing, and other restrictions.

Herbicide labels are constantly being updated. Before using any herbicide, check the label for specific use under your conditions. For a list of herbicides labeled for use on forage sorghums, consult the “Western Forage Production Guide” located at [http://forages.nmsu.edu/documents/westernforageguide\\_final.pdf](http://forages.nmsu.edu/documents/westernforageguide_final.pdf), or contact your county Extension agent.



**Figure 1.** Sudangrass densely planted, resulting in small stems and a high proportion of leaves.

### Harvesting

Forage sorghum grown for silage should be harvested when the grain has reached the mid- to late-dough stage of maturity or when whole plant moisture content is between 60 and 70%. At this stage, yield and forage quality are maximized and animal acceptance of the final ensiled product is high. Harvesting above 70% moisture may lead to improper ensiling and excessive effluent, or seepage, from the silo; this is particularly true of upright silos where greater pressure is exerted on lower layers of silage. Bunker or trench silos should be used if moisture content is above 70%. Regional observations have been that forage sorghum drydown is more difficult to obtain and predict than corn, and, as a result, sorghum is often harvested too wet. There are situations where forage sorghum is at the proper grain maturity but still has a total plant moisture content above 70%. In these cases, the addition of additives could reduce the impact of the high moisture. Producers must weigh the pros and cons of harvesting at high moisture and decide if it is worth running the risk of high dry matter losses and producing effluent. On the other hand, excessively dry silage will not pack well and eliminating oxygen will be difficult, thereby causing high temperatures, heat-damaged protein, and a more indigestible, lower energy product. Harvesting both too early and too late will reduce energy of the fed product. It is important to keep in mind that much variability exists among the many different cultivars of forage sorghum with respect to seasonal maturity, grain-

to-stover ratio, plant height, lodging potential, and dry matter content. Growers should choose varieties that are well adapted to their regional growing conditions and should avoid planting types that have phenotypic extremes of the characteristics listed above (Bolsen, 2004).

Although silage yields of sorghums may be greater than those of corn, forage nutritive value (i.e., energy) is often slightly lower than corn (Marshall et al., 2009a, 2009b). Harvesting at the proper stage will help minimize this discrepancy. For this reason, forage sorghum silage may be best utilized in situations where livestock energy requirements are not at a maximum. Protein levels in forage sorghum are equal to or higher than levels in corn, and crude protein proportions in sorghum decline with maturity. Digestibility of sorghums has been improved through years of breeding research and the introduction of the brown midrib (BMR) trait (this trait is described in greater detail in the **Brown Midrib (BMR) Sorghums** section). As a result, some sorghum cultivars now have energy values equal to those of corn, and their acceptance among feeding industries that require high energy (e.g., dairies) is growing. Even if their energy is inferior to corn, these large sorghums still have great potential for use in New Mexico where water is limiting and corn production is not possible, or in situations where growers are looking to produce a medium- to high-energy silage with fewer inputs and lower overall costs.

### Sudangrass and Sorghum-Sudangrass Hybrids (Hay Production and Grazing)

True sudangrass is a relative of cultivated sorghum and is characterized by small, fine stems and leafy growth. These grasses regrow rapidly after cutting or grazing and can produce dense stands when planted at high rates (Figure 1). Sudangrasses are used less extensively now than in the past and have been replaced in large part by sorghum-sudangrass hybrids in grazing and haying operations, for which they are well suited. Sorghum-sudangrass hybrids (SXS) are, as the name indicates, crosses of true sudangrass and other types of sorghum, mainly forage sorghum types. Both grasses are heat- and drought-tolerant, tiller extensively, regrow well after defoliation, and winterkill at first frost. Commonly used varieties grow from 6 to 8 feet tall and can be cut

multiple times during a growing season. Hybrids maintain the tall stature associated with forage sorghums, but have smaller stems than the silage types and higher yields than sudangrass, thereby making them better suited for hay and pasture production. As a result, they are often referred to as “Haygrazer.” Sudangrasses are considered medium-yielding and are perhaps best suited as annual pasture grasses. Because of their rapid growth and fibrous root system, sudangrasses and hybrids make excellent cover crops that improve soil structure and organic matter, while their dense growth and residue suppress weeds.

### **Fertilization**

Management is similar for sudangrasses and SXS hybrids, and soil pH and fertility requirements are similar to those described for forage sorghums. They are best adapted to well-drained, fertile soils, but are moderately productive on poorer soils. However, because they are typically managed either as hay or for grazing, fertilizer requirements after planting will differ. General recommendations are that sudangrasses and SXS hybrids should be fertilized with 60 to 90 lb N/ac at planting and then 40 to 60 lb N/ac after each cutting or every 4 to 6 weeks if grazing. While initial nitrogen requirements (at planting) are less than those of high-yielding forage sorghums, total seasonal requirements may equal or exceed forage sorghum because multiple applications are made after cuttings or grazing removal. Phosphorus and potassium additions should be based on soil tests. As with forage sorghum, if P and K levels are determined to be “low,” applications of 30 to 80 lb/ac of each may be warranted. While incorporated broadcast applications of K are common, band application of P into the root zone will be most efficient and effective. Rates for broadcast P are about twice as much as those of banded.

### **Establishment**

Sorghum-sudangrass hybrids and sudangrasses are seeded most commonly by either broadcast or drilling methods; however, some growers may choose to use a planter with wider row spacing. In some dryland situations (e.g., low soil moisture, rough seedbed, old drill), a planter may be a better choice since it allows for good placement of

the seed into soil moisture, reduced seeding rates, and wider rows for cattle to move through if grazing (Trostle, 2005). Again, seeding rates will vary depending upon intended use, seed size, irrigation, and row spacing. In general, sudangrasses and hybrids are seeded at higher rates than forage sorghums and have similar seed size (avg. 16,000 seeds/lb). Assuming this seed size, a wider row spacing (>20 inches) will require lower seeding rates ranging from 5 to 10 lb/ac, depending on whether it is an irrigated or dryland system. Rates on irrigated land are about 1 1/2 to 2 times greater than on dryland. Drilled plantings (6- to 20-inch rows) should be seeded from 10 to 15 lb/ac in dryland systems to up to 20 lb/ac in irrigated systems. Recall that seeding at higher rates will decrease stem size and improve forage quality and palatability; this is particularly important in haying systems. The seeding rates mentioned here are averages based on research, regional observations, and experiences in various parts of the country, and should only be used as guides to help determine what is appropriate for each grower’s individual situation. These grasses should not be planted until soil temperatures reach 65°F; planting depths may be as shallow as 3/4 inch on heavy soils or as deep as 1 1/2 inches on sandier soils.

### **Weed Control**

Weed control in SXS hybrids is similar to forage sorghums; however, growers should be aware that even fewer herbicide options are available for SXS hybrids and sudangrasses because of label restrictions. Also, seed from certain varieties of forage-type sorghums do not take the Concep seed treatment very well, and this could lead to reduced crop emergence if metolachlor is used.

### **Harvesting**

Harvesting sudangrasses and SXS hybrids for hay should be done at the late boot stage of maturity (just prior to head emergence) or when plants are about 40 inches tall. Earlier cutting will provide higher quality hay, but yields will be lower if plants are not allowed to reach the boot stage. If plants are permitted to mature beyond heading, nutritive value of the hay will be compromised. First cuttings are achievable as early as 40 to 60 days after planting (24-inch minimum height), followed by

harvests every 21 to 35 days thereafter. In some dryland fields, only one cutting is obtainable, and in these situations growers may choose to let the grasses mature past heading in order to maximize tonnage rather than quality. A minimum of 6 inches of stubble should remain after cutting to promote adequate regrowth.

Most sorghum hay is difficult to dry because of large stems and the waxy cuticle that prevents moisture loss. Therefore, it is likely that some form of conditioner (e.g., crusher, crimper, tedder) will be needed to help dry the large stems. Due to the slow drying time and overly mature plants that are often harvested, there is great potential for significant hay quality reductions with these crops. Growers should do everything possible to limit the decline in nutritive value. Harvesting at the correct stage, promoting rapid drying (e.g., heavy conditioning, wider windrows), and limiting exposure to environmental elements (covering bales) will all aid in preserving the valuable nutrients contained within the forage. With proper management, these sorghums can produce good quality hay for several classes of livestock.

Grazing the grasses provides the cheapest method of harvesting; however, grazing operations require the greatest amount of management in order to match the nutrition present in the forage to the needs of livestock. Once plants are at least 18 to 24 inches tall, animals can be allowed to graze. Rotational stocking is recommended for a few reasons. First, it promotes selective grazing of more nutritious, leafy material, which in turn may increase animal productivity (i.e., body weight gains, milk production). Animal performance is often inferior if livestock are forced to graze stems after leaves are consumed. Allowing plants to become too mature decreases nutritive value and animal performance. High stocking rates are usually required in order to utilize the rapidly maturing plants and to maintain high quality. Second, rotating animals will minimize trampling of plants and fouling by excrement. Finally, as with hay cuttings, a stubble height of at least 6 inches should be left for vigorous regrowth. Rotational stocking prevents grazing plants too short. Also, thin-stemmed varieties recover from close grazing or cutting more rapidly than those with larger stems (Fribourg, 1995). Toxicity problems associated with sorghums are more of a concern with

grazing animals than with feeding hay or silage (see **Toxicity Concerns** section).

Although forage sorghums are better suited for ensiling, sudangrasses and SXS hybrids may be cut for a one-time silage harvest at the soft- to mid-dough stage of grain maturity. See **Forage Sorghum (Silage Production)** section for proper silage management.

### **Brown Midrib (BMR) Sorghums**

Much interest has been generated in recent years by the introduction of sorghum plants containing the brown midrib (BMR) gene. This trait, in both forage sorghums and SXS hybrids, is characterized genetically by lower lignin concentrations in the plant compared with conventional types. Lignin is the primary indigestible component of many forages and significantly reduces digestibility within animals consuming plant material (leaves and stalks). Reducing lignin in the plant has led to improved palatability and digestibility of several sorghum cultivars, whether baled or grazed. Additionally, BMR forage sorghums have exhibited nutritive values similar to corn silage while using less water to produce comparable yields. However, it should not be overlooked that there are concerns associated with this relatively new trait. Research suggests that the various types of BMR mutations can lead to reduced dry matter yield, height, tillering ability, and regrowth after harvest, and increased lodging (Pedersen et al., 2005), but these problems are often variety-specific, and certain cultivars perform better than others. More recent cultivars resulting from breeding efforts have eliminated some of the concerns associated with first-generation BMR sorghums. However, research continues to indicate that yields are slightly lower than those observed in conventional types. In short, the overall suitability of BMR forages as a consistent alternative to conventional types is still in question. The BMR trait is phenotypically (outward appearance) characterized by a brown midrib (Figure 2) on leaves that may or may not be readily distinguishable from a conventional leaf midrib; on some varieties, brown coloration is obvious on both the leaf midrib and on stems.

Management of BMR forage sorghum and SXS hybrids will vary depending on cultivar, intended use, and environmental conditions to which they are exposed. Research in New Mexico and Texas



**Figure 2.** Midribs of brown midrib (left) and conventional (right) forage sorghum leaves.

suggests that BMR sorghums should be planted at lower rates (e.g., 3 to 5 lb/ac) and that less nitrogen be applied. Planting at lower rates will increase individual stalk size and reduce the incidence of lodging. While large stems in conventional cultivars may adversely impact forage quality, it is suggested that the reduced lignin in BMRs will offset the negative effects associated with larger stems. Standability (lodging) is more of a concern if the forage is allowed to head out; therefore, plants managed as a silage crop warrant reduced seeding rates and conservative nitrogen fertilization. Your local seed dealer can help provide proper seeding rates that are recommended for specific BMR varieties as they relate to your production goals and growing conditions. Harvest management for BMR sorghums is similar to that of conventional sorghums described previously.

### **Brachytic Dwarf Forage Sorghum**

Brachytic dwarf forage sorghum, as the name implies, is generally shorter than conventional varieties (less than 6 feet in height; Figure 3). These varieties are characterized by short internodes, which give the plants a leafy, lush, green appearance. Varieties are available that combine the brachytic dwarf and BMR traits. These varieties are new, and limited testing has been completed in university trials. However, early testing has indicated that yields are near or slightly less than limited input corn, but considerably lower than top-producing conventional

forage sorghums. It is expected that overall nutritive value will be improved as a result of the higher leaf-to-stem ratio compared to conventional forage sorghum. This, combined with the BMR trait and the decreased likelihood of lodging, may make the brachytic dwarf sorghums an appealing option for silage growers looking to maximize nutrition.

### **Photoperiod Sensitive Sorghums**

Photoperiod sensitive (PS) sorghum is another type of sorghum that is characterized by tall growth and large dry matter yields. It differs from conventional and BMR forage sorghums in that it requires a day length of about 12 hours or less (long nights) for the reproductive stages of flowering to begin. Plants will remain in the vegetative stage for longer periods during the growing season and, in fact, some varieties may never flower before growth is stopped by frost in the fall. As a result, PS plants can become very tall (14 feet or more) by the end of summer if they are not cut (Figure 4).

These varieties should be used primarily for grazing or hay production, or possibly as green chop. The problem with using PS sorghum as silage is that the nutritive value is not up to par with other sorghum types, and their moisture level at harvest is usually too high for proper ensiling. Instead, growers have the advantage of longer hay cut windows and more days for animals to graze nutritious leafy forage. This may be especially advantageous in hay



*Figure 3.* Brachytic dwarf sorghum near maturity (foreground). Notice short height compared to conventional forage sorghum (background and left).



*Figure 4.* Photoperiod sensitive forage sorghum. Note the tall height and lack of seed head.

operations when rain delays harvest. Management of PS sorghums is similar to that of conventional forage sorghums with respect to soil fertility, planting dates, grazing, hay harvesting, and regrowth allowance. It is recommended to increase seeding rates and promote fine stems on PS sorghum in order to offset the low nutritive value common to these forages. Several seed companies are now marketing both late-maturing and true PS varieties of forage sorghum and SXS hybrids.

### **Toxicity Concerns**

Sorghum grasses have the potential to be very toxic to animals consuming them. Two concerns that producers should be aware of are nitrate toxicity and prussic acid (hydrogen cyanide; HCN) poisoning. Both of these conditions can develop rapidly without much warning, and many times it is too late by the time the problem has been diagnosed. As a general rule, anything that suppresses or disrupts growth of leaves relative to root absorption (i.e., drought, overcast days, frost, low temperatures, shading, herbicide damage, hail, disease) could contribute to increased levels of nitrates and HCN in the plant. Excessive nitrogen fertilization may result in toxic forage as well, especially when combined with drought stress.

Nitrates, when converted to nitrites in the rumen, interfere with the ability of red blood cells to carry oxygen, and animals can die from asphyxiation. Symptoms of nitrate toxicity appear as rapid/

labored breathing, staggering and collapse, muscle tremors, diarrhea and frequent urination, and a distinct chocolate-brown coloration to the blood. Caution is warranted when nitrate levels in forage exceed 2,500 ppm (0.25%) on a dry matter basis (Table 2). In general, nitrate levels are higher in the stems than in leaves, especially the lower stem. Nitrate toxicity is more likely if stocking rates are such that cattle are forced to graze stalks or when cut or chopped forage is cut low to the ground.

Prussic acid is formed from naturally occurring cyanogenic glycosides in the plant and is readily absorbed in the bloodstream, leading to respiratory problems and eventual death if high enough concentrations are consumed. To complicate matters, HCN poisoning is characterized by symptoms similar to nitrate poisoning and, in some situations, both conditions may be present at the same time. Blood taken from an animal with only HCN poisoning will not be brown, but will instead be a bright cherry-red color. Prussic acid exceeding 600 ppm (0.06%) on a dry matter basis should be fed sparingly (Table 3). Young, tender growth often contains more HCN than mature growth, and plants must be at least 18 inches tall before turning animals out on pasture. Prussic acid levels tend to be greatest in leaves.

Waiting four to seven days after a stressful environmental condition (e.g., drought or frost) before allowing animals to graze is recommended; forages should be tested before any type of grazing or

**Table 2. Nitrate Concentrations and Respective Management**

Nitrate level (ppm, DM basis)	Status	Comments
0 - 2,500	SAFE	Generally considered safe to feed.
2,500 - 5,000	CAUTION	Generally safe when fed with a balanced ration. Limit to 1/2 of total dry ration for pregnant animals. Do not feed with other non-protein nitrogen supplements. Caution with young animals.
5,000 - 15,000	DANGER	Limit to 1/4 of ration. Possible reproduction problems and milk losses.
Over 15,000	TOXIC	Do not use in free choice feeding program. Should be ground and limited to 15% of total ration.

Source: Ball et al. (2001).

**Table 3. Prussic Acid Concentrations and Respective Management**

Prussic acid content (ppm)		Comments
As fed basis	Dry matter basis	
<200	<600	Safe to feed.
200 - 600	600 - 1,800	Potentially toxic. Should be fed at a restricted rate.
>600	>1,800	Potentially very toxic. Dry, ensile, allow to mature prior to feeding or grazing. Retest before feeding.

feeding. Haying toxic forage will not reduce nitrate levels, but because HCN converts to a gas, it will deteriorate as hay is dried down. As a result, prussic acid poisoning is more of a problem in grazing situations. Nitrates, on the other hand, will persist in hay, and high-nitrate hay should be limited in the animal's diet (Table 2). Ensiling will reduce nitrates by about 30 to 50%. Hungry cattle should not be given potentially toxic hay or allowed to graze suspect pastures.

It is recommended to not allow horses to graze any of the sorghums on pasture as prussic acid poisoning and urinary tract problems (cystitis) are likely to develop. Although HCN breaks down in hay, feeding sorghums to horses is discouraged. Due to the difficulty of drying thick stems, sorghums are often baled moist, leading to mold production and subsequent respiratory problems in horses. For more information on nitrate toxicity and prussic

acid poisoning, consult Cooperative Extension Service Guide B-807: *Nitrate Poisoning of Livestock* and Guide B-808: *Prussic Acid Poisoning in Livestock*, both available at [http://aces.nmsu.edu/pubs/\\_b/](http://aces.nmsu.edu/pubs/_b/).

## REFERENCES

- Allison, C.D. 2010. *Nitrate poisoning of livestock* [Guide B-807]. Las Cruces: New Mexico State University Cooperative Extension Service.
- Allison, C.D., and R.D. Baker. 2002. *Prussic acid poisoning in livestock* [Guide B-808]. Las Cruces: New Mexico State University Cooperative Extension Service.
- Anderson, B., and P. Guyer. 1986. *Summer annual forage grasses* [NebGuide G74-171A]. Lincoln: University of Nebraska Cooperative Extension.
- Ball, D.M., C.S. Hoveland, and G.D. Lacefield. 1991. *Southern forages*. Norcross, GA: Potash & Phosphate Institute.
- Bolsen, K.K. 2004. Sorghum silage: A summary of 25 years of research at Kansas State University. Southeast Dairy Herd Management Conference, Macon, GA. Nov. 16–17, 2004.
- Butler, T., and B. Bean. n.d. *Forage sorghum production guide*. Stephenville: Texas Agricultural Experiment Station. Available from <http://www.soilcropandmore.info/crops/Annual-Forage-Sorghum/ForageSorghumProdGuide.pdf>
- Fribourg, H.A. 1995. Summer annual grasses. In R.F. Barnes et al. (Eds.), *Forages, vol. 1*, 5th ed. (pp. 463–472). Ames: Iowa State University Press.
- Howell, T.A., J.L. Steiner, A.D. Schneider, S.R. Evett, and J.A. Tolck. 1997. Seasonal and maximum daily evapotranspiration of irrigated wheat, sorghum, and corn—Southern High Plains. *Transactions of the ASAE*, 40, 623–634.
- Marsalis, M.A., and B. Bean. 2010. *Western forage production guide*. Lubbock, TX: United Sorghum Checkoff Program.
- Marsalis, M.A., S.V. Angadi, and F.E. Contreras-Govea. 2009a. Dry matter yield and nutritive value of corn, forage sorghum, and BMR forage sorghum at different plant populations and nitrogen rates. *Field Crops Research*, 116, 52–57.

- Marsalis, M.A., S. Angadi, F.E. Contreras-Govea, and R.E. Kirksey. 2009b. *Harvest timing and byproduct addition effects on corn and forage sorghum silage grown under water stress* [Bulletin 799]. Las Cruces: New Mexico State University Agricultural Experiment Station.
- Martin, J.H., W.H. Leonard, and D.L. Stamp. 1976. *Principles of field crop production*. New York: Macmillan Publishing Co., Inc.
- Mortvedt, J.J., D.G. Westfall, and R.L. Croissant. 1996. *Fertilizing grain and forage sorghums* [Soil. Crop Series. No. 0.540]. Fort Collins: Colorado State University Cooperative Extension.
- Pedersen, J.F., and J.O. Fritz. 2000. In C.W. Smith (Ed.), *Sorghum: Origin, history, technology, and production – Forages and Fodder* (pp. 797–810). Hoboken, NJ: John Wiley & Sons, Inc.
- Pedersen, J.F., K.P. Vogel, and D.L. Funnell. 2005. Impact of reduced lignin on plant fitness. *Crop Science*, 45, 812–819.
- Sanderson, M.A., R.M. Jones, J. Ward, and R. Wolfe. 1992. *Silage sorghum performance trial at Stephenville* [Forage Research in Texas, Report PR-5018]. Stephenville: Texas Agricultural Experiment Station.
- Sattell, R., R. Dick, R. Ingham, R. Karow, and D. McGrath. 1998. *Sudangrass and sorghum-sudangrass hybrids* [EM 8703]. Corvallis: Oregon State University Extension Service.
- Teutsch, C. 2002. *Warm-season annual grasses for summer forage* [Pub. 418-004]. Blacksburg: Virginia Polytechnic and State University Cooperative Extension.
- Trostle, C. 2005. *Dryland sorghum/sudan-planter vs. drill*. Focus on Entomology. Lubbock: Texas Agricultural Experiment Station.



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