Kansas Sorghum Management 2016

MF3046

Crop Production

How to Use This Guide

This publication helps producers manage their sorghum crop as efficiently and profitably as possible under Kansas growing conditions. Recommendations should be considered as guidelines and must be tailored to situations based on the cropping system, soils, and weed populations encountered in that field.

Tillage and Rotations

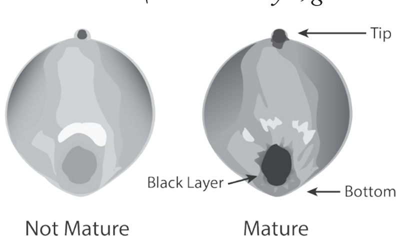
Uniform residue distribution, effective weed control, proper seed placement, correct planter adjustment, soil testing, and fertilizer management are important for success in conservation-tillage systems.

Crop sequencing and rotation become increasingly important in systems with little or no tillage and greater amounts of surface residue cover. Long-term research in Kansas has documented greater yield advantages for rotated sorghum vs. continuous sorghum in no-till (9 to 16 bushels per acre) compared to conventional tillage systems (2 bushels per acre).

Hybrid Selection

Base hybrid selection on maturity, resistance to pests (insects and diseases), and stalk strength, but also consider: head exertion, seedling vigor, and hybrid performance. Hybrid maturity is related to the probability of entering into physiological maturity 1 to 2 weeks before the first freeze. A hybrid is physiologically mature when its black layer forms (black line at the grain base), which coincides with the cessation of dry matter accumulation (Figure 1). Use a shorter-season hybrid when late planting occurs, mid-June in north central or northwest Kansas, late June in south central and southwest, or July in eastern Kansas. When planted early, long-season hybrids are recommended for making use of the full length of the growing season (greater yield potential).

Figure 1. *Grain sorghum physiologically "not mature" (grain on the left side) and "mature" (with black layer, grain on the right side).*



Standability is a positive trait under adverse environments. When possible, harvest the fields that present issues in stalk strength first.

Plant so blooming occurs in favorable conditions, avoiding hot/dry weather, but allow sufficient time for maturing before the first fall freeze.

To diversify risk, plant multiple hybrids with different maturities to minimize the effect of short-term adverse environmental conditions. The full exertion trait is preferred to poor head exertion due to improvements in grain set development and lower susceptibility to biotic stress (e.g. mold).

Planting Practices

Planting date. Grain sorghum can be planted over a wide range of dates. Time planting so flowering avoids the hottest, driest period of summer but still allows time to mature before frost.

Row width. Row spacing influences productivity when sorghum yields are greater than 70 bushels per acre. Under low-yielding environments, conventional (30-inch) row spacing seems to be the best option.

Clump planting demonstrates a similar but inverse relationship in water-limited conditions. Planting sorghum in clumps of three or four plants every 30 inches within rows spaced 30 inches apart reduces tillering and results in greater use of water in grain production rather than leaf and stem production. Clump planting shows similar or better yield response than uniformly spaced plants with yields below 80 bushels per acre. Above 80 bushels per acre, the uniform plant arrangement out yields clump planting. Seeding rates for clump planting arrangements should be similar to those recommended for uniform spacing.

Seeding rate. When seeding in narrow rows in high-yielding environments, populations 25 to 30 percent higher than recommended in Table 1 may increase yields. Higher seeding rates should be used with later planting dates because sorghum plants tend to produce fewer productive tillers with warmer temperatures during the vegetative growth stages.

Seed size varies, which can affect emergence, but it generally has a minimal influence on yield.

Sorghum plants can compensate for large differences in stand. Thin stands tend to have more heads per plant and/or larger heads (more seeds per head). High plant density results in fewer tillers and thinner stems,

Table 1. *Grain sorghum recommended plant and seed spacings.*

	Average annual rainfall (inches)				
	<20	20–26	26–32	>32	Irrigated
	Target plants per acre (x 1,000)				
	23-27	25–45	35–55	50–90	80-110
	Seeds / acre (x 1,000; 70% emergence)				
	30–35	35–64	50–80	70–125	110-150
Row Spacing	Within-row seed spacing at planting assuming 70% field emergence				
8-inch	26–22	22–12	16–10	11–6	7–5
10-inch	21–18	18–10	13–8	9–5	5–4
15-inch	14–12	12–7	8–5	6–3	4–3
20-inch	10–9	9–5	6–4	4–2	3–2
30-inch	7–6	6–3	4–3	3–2	2–1

Table 2. *Seed size factor, average seed weight and seeds per pound as related to the crop condition.*

Yield Range (bu/a)	Crop Condition	Average Seed Weight (g/1,000)	Seeds Per Pound
<50	Very Poor	24.5	18,520
50-100	Poor	25.5	17,793
100-150	Fair	26.2	17,318
150-200	Good	25.6	17,723
>200	Excellent	25.5	17,793

which increase the susceptibility to drought and lodging.

Nonuniform stands and replanting. Sorghum yields are not reduced unless gaps are at least 9 feet long or a sufficient number of 3-foot to 6-foot gaps reduce stands by 30 percent or more.

Estimation of yields before harvest. Perform yield estimation 3 to 4 weeks after flowering (see examples in inset). Both final seed number and weight can change from this point to the end of the season, although estimations will be more precise as the crop gets closer to full maturity stage. The on-farm approach consists in counting the total number of heads in a 17.4-foot length of row (one row) with 30-inch row spacing. Two and four rows need to be measured if the row spacings are 15-inch and 7.5-inch, respectively. Only heads more than 3 inches in length should be counted in this row-length. Two more steps need to be added: estimation of the final number of seeds per head and seed size or weight. The total number of seeds is the main factor driving sorghum yields; while the seed size is less variable and is not well correlated with the final yield (Table 2). Dry and hot conditions greatly affect the total number of seeds per head, but if conditions improve during grain fill, the seed weight can compensate to a limited extent.

Example A: *Good Crop Condition*
((62 heads × 2,500 seeds per head × 1,000) ÷ 17,723) ÷ 56 = 156 bushels per acre

Example B: *Very Poor Crop Condition*
((40 heads × 900 seeds per head × 1,000) ÷ 18,520) ÷ 56 = 35 bushels per acre

Weed Control

Weed control remains a challenge and is best achieved with an *integrated approach* using crop rotation, good crop production practices, herbicides, and if required, tillage to enhance the ability of sorghum to compete with weeds. Base weed-management programs on previous years' field notes indicating weed species, their relative abundance, and locations of perennial-weed infestations. Sorghum should remain nearly weed free for the first 4 to 5 weeks after planting to prevent yield loss from weed competition.

In grain sorghum, using a preemergence herbicide with good grass activity is essential for adequate control of annual *grassy weeds*. Rotations with crops that allow the use of preemergence and postemergence grass herbicides can prevent seed production during that growing season. Because seed viability for many grassy weeds is relatively short, controlling them for 4 to 5 years greatly reduces the grass weed pressure in future growing seasons. Prevent grass weeds from producing seed during a fallow period. Do not plant grain sorghum when expecting a shattercane, johnsongrass, or longspine sandbur infestation.

Successful control of *annual broadleaf weeds* requires planting sorghum into a weed-free environment and implementing other practices that promote sorghum emergence before weed emergence. Timely postemergence applications to small broadleaf weeds, following a preemergence herbicide, provide the most effective season-long weed control.

Crop rotation is a key component of integrated weed management because it reduces weed pressure by varying the timing and types of herbicides and tillage used. This is the most effective control for shattercane, johnsongrass, and longspine sandbur. Timely herbicide applications providing good weed control in rotational crops and during fallow periods are essential.

In no-till seedbeds, once several flushes of weed seedlings have been controlled with herbicides without further soil disturbance, weed pressure often is reduced because few weed seeds remain in the germination zone near the soil surface. No-till practices especially reduce the large-seeded broadleaf weed populations.

An atrazine application in late October or into November helps control winter annual weeds and volunteer wheat. It should keep the field relatively weed free for no-till sorghum planting the next spring. Add glyphosate if winter annual grasses are present and 2,4-D for adequate winter annual broadleaf weed control. Fall treatment is best for managing henbit, field pansy, and glyphosate-resistant marestail.

Glyphosate and 2,4-D or dicamba can provide excellent broad-spectrum weed control in *wheat stubble* to prevent weed seed production. In areas with glyphosate-resistant Palmer amaranth and waterhemp, the use of Gramoxone, active ingredient paraquat, has been an effective burndown provided good coverage is achieved.

Glyphosate-resistant weed species require timely applications of herbicides, effective preemergence herbicides, and careful selection of postemergence products. Marestail is best managed with fall-applied herbicide treatments and the addition of growth regulators with glyphosate in early spring burndown and again before planting (see labels for planting restrictions). Growth regulators with glyphosate control glyphosate-resistant giant and common ragweed. Manage glyphosate-resistant Palmer amaranth and waterhemp with effective PRE applied herbicides. Glyphosate-resistant kochia requires November to early March applications of atrazine and dicamba before kochia emergence to manage the initial flush of kochia. Using effective PRE herbicides containing atrazine greatly assists season-long kochia control.

Sorghum planted into soybeans or row-crop stubble normally requires no seedbed preparation other than a burndown herbicide application. Where weed pressure is light, and mainly from broadleaf weeds, a March or early-April application of atrazine with crop-oil concentrate and 2,4-D can control winter annual weeds such as mustards and marestail and provide control of most germinating weeds up to planting. Early-spring-applied atrazine minimizes off-site atrazine movement, because there is little potential for loss in surface-water runoff compared to later planting-time applications. Leaving these weeds uncontrolled until after or just before grain sorghum planting can result in inadequate weed control.

If *annual grasses and tough broadleaf weeds* such as velvetleaf emerge near planting, glyphosate and 1 pint of 2,4-D ester, (8 ounces Clarity or Banvel if kochia is present) should be applied at least 1 week before planting. In addition to killing emerged annual weeds, this treatment can be effective on established perennials such as field bindweed and hemp dogbane. Soil-residual grass herbicides can be added with these foliar-applied treatments for extended weed control.

Soil-applied preemergence herbicides for grass and pigweed control in sorghum may be shallowly incorporated or surface applied. These herbicides require the use of sorghum seed treated with a safener. These soil-applied herbicides do not control shattercane or large-seeded broadleaf weeds such as cocklebur, velvetleaf, venice mallow, morningglory, devilsclaw, or sunflower. These herbicides are most effective when applied with atrazine and often are marketed in a prepack mixture. Prepack mixtures that include atrazine provide broad-spectrum grass and broadleaf weed control; however, the mixtures do not adequately control some triazine-resistant broadleaf weeds (e.g. Palmer amaranth and kochia). Lexar EZ or Lumax EZ herbicides can provide some control of large-seeded broadleaf weeds, including velvetleaf.

Several herbicides may help control *large-seeded broadleaf and triazine-resistant weeds.* Sharpen contains a PPO-inhibiting herbicide, saflufenacil, that provides burndown broadleaf weed control and short residual broadleaf weed control including control of large-seeded broadleaf weeds. Verdict is a premix of saflufenacil + Outlook and can be used in sorghum. One to 2-ounces per acre of Sharpen or 5- to 10-ounces of Verdict may provide 1 to 2 weeks residual broadleaf weed control. If applying postemergence to broadleaf weeds, include methylated seed oil to optimize activity. Sharpen or Verdict must be applied with one of the chloroacetamides or one of the prepackaged mixtures of a chloroacetamide and atrazine. Lumax EZ or Lexar EZ contain the HPPD-inhibiting herbicide mesotrione (Callisto) plus Dual II Magnum and atrazine. Lumax EZ is the low-atrazine load version of these prepack herbicides. If atrazine cannot be used, Zemax contains mesotrione (Callisto) plus Dual II Magnum; however, it provides less broad spectrum weed control because of the absence of atrazine. Lumax EZ or Lexar EZ can provide excellent control of grasses and broadleaf weeds including velvetleaf and triazine-resistant Palmer amaranth and kochia. Do not use Lumax EZ, Lexar EZ, and Zemax on sandy soils because of excessive risk of crop injury and stand loss.

Where soils are vulnerable to surface-water runoff during May and June, the rate of atrazine applied to the soil surface at planting should not exceed 1 pound per acre. Alternatives for using higher rates of atrazine at planting include surface application before April 15, preplant incorporation, or application in bands over the sorghum row.

Apply *postemergence herbicides* to small weeds for optimum weed control. Bromoxynil (Buctril, Moxy, and others), carfentrazone (Aim and others), Huskie, and atrazine all control weeds through foliar contact and do not readily move through the plant; therefore, weeds may recover even after having lost their leaves. This is especially true when larger weeds are treated. Contact herbicides are most effective when applied with higher spray volumes up to 20 gallons per acre.

Systemic herbicides such as 2,4-D, Banvel, Starane, Peak, Permit, Facet L, and Yukon are translocated from the leaf surface throughout the plant and are most effective on small annual broadleaf weeds and can be effective on perennial weeds. Facet L effectively controls field bindweed. Permit and Yukon are quite effective at controlling yellow nutsedge. Several generic herbicides may contain these active ingredients.

Fewer herbicides are available for *broadleaf weed control* in sorghum than in corn or soybeans. Products such as bromoxynil plus atrazine, dicamba plus atrazine, and 2,4-D + atrazine contain about 0.5 pound atrazine. They should be applied when sorghum is in the three- to six-leaf stage, not exceeding 12 inches tall and weed sizes conform to label guidelines.

Huskie is a premix of pyrasulfotole (HPPD-inhibiting herbicide) and bromoxynil and should be applied at 12.8 to 16 fluid ounces per acre with 0.25 to 1.0 pound per acre atrazine, 0.25 to 0.5 percent v/v NIS, and AMS at 1 pound per acre to sorghum that is three-leaf stage to 12 inches tall. Without atrazine, Huskie can be applied to sorghum 12 to 30 inches tall before flagleaf emergence. A maximum of 32 fluid ounces of Huskie per acre may be applied in a season; however, 11 days must separate the two applications. Huskie often causes some sorghum injury and can cause unacceptable injury if preemergence-applied Lumax EZ or Lexar EZ had previously caused injury. Huskie provides excellent control of pigweed species, morningglory, sunflower, velvetleaf, and kochia. Kochia and Palmer amaranth may not be controlled adequately when plants are taller than 4 inches.

Peak, Permit, and Ally are *sulfonylurea* (SU) *herbicides* that work by inhibiting the acetolactate synthase (ALS) enzyme. Ally must be applied with 0.25 pound ae 2,4-D amine to reduce the grain sorghum injury from Ally. The other SU herbicides are often tank mixed with dicamba, 2,4-D, and/or atrazine to control a broader spectrum of weeds and to help control ALS-resistant weed species. Kochia, Palmer amaranth, and waterhemp are frequently ALS-resistant and not controlled with ALS herbicides.

Additional herbicides available for *postemergence broadleaf weed control* are Aim (carfentrazone) and Priority (Aim + Permit). Aim is a PPO inhibitor and can help control triazine- and ALS-resistant weeds if applied when weeds are small. Aim is especially effective for control of velvetleaf.

Dicamba (Banvel or Clarity) and 2,4-D are among the least expensive herbicides for broadleaf weed control in sorghum. These growth regulator herbicides often can cause temporary leaning and brittleness in sorghum. These plants are more vulnerable to wind and cultivator damage. Use drop nozzles when applying to sorghum taller than 8 inches. Application of 2,4-D or dicamba after sorghum exceeds 15 inches tall may result in sterility and severe yield reduction.

See K-State Research and Extension publication *2016 Chemical Weed Control for Field Crops, Pastures, Rangeland and Noncropland,* SRP1126 for more herbicide and weed control recommendations.

Irrigation Management

Grain sorghum peaked in popularity as an irrigated crop in the early to mid-1980s but remains as one of the top five irrigated crops in Kansas. About three percent of the 3 million irrigated acres in Kansas are planted to irrigated grain sorghum annually.

The statewide average yield of grain sorghum has been increasing at about 0.6 bushels per acre since 1974, reaching a statewide average of 100 bushels per acre for irrigated production. In 2014, the highest yields in the K-State irrigated grain sorghum performance tests at the Colby, Garden City, and Tribune test sites were 226, 193, and 209 bushels per acre; the average test yields of the tests were 184, 146, and 163 bushels per acre respectively. From 2008 through 2014, the average bushel per acre yield of the top 5 performing varieties for each of the locations were 181 at Colby, 150 at Garden City and 175 at Tribune.

Grain sorghum uses about 18 to 26 inches of water to produce a normal yield in the western part of Kansas. Requirements are less in the eastern part of the state due to higher relative humidity and lower wind speeds. The amount of irrigation needed depends on the season and the amount of soil water stored in the root zone. Dry-year-irrigation estimates for grain sorghum range from about 15 inches in southwest Kansas to less than 7 inches in southeast Kansas. Irrigation estimates for years with average rainfall are from about 13 inches in the west to 4 inches in the east. These estimates are for well-watered conditions.

Factors determining water include planting date and maturity length. Grain sorghum is generally one of the later-planted summer crops. Average peak water-use rates are about 0.3 inch per day, although occasionally a single-day peak use might approach 0.5 inch per day, similar to the peak use rate of any field crop at full cover and active growing conditions.

A crop-production study conducted at Garden City from 2006 to 2012 examined multiple crop rotations including grain sorghum following wheat. The precipitation varied over the years, including above-average years in 2007 and 2009 and drought years in 2011 and 2012. Figure 2 shows the yield response of grain sorghum to various irrigation amounts and the average yield response. The data show that about 6 inches of water are needed to initiate grain yield and yield increases linearly with water use at a rate of about 10 bushels per inch of water use. The amount of irrigation water needed to achieve various yield levels is seasonally dependent as shown in Figure 3. Note in wetter years near maximum yield levels were achieved with 7 or 8 inches of irrigation water, while during drought years around twice as much irrigation was needed to achieve the same yield levels. The year-to-year and in-season variability indicates the need for an irrigation scheduling procedure for effective water management. The low water use requirement for yield initiation and its ability to maintain water productivity under limited irrigation (see Table 3) makes grain sorghum a good option for irrigators with low-capacity wells or limited water.

Figure 2. *Yield response of grain sorghum at various levels of crop water use at Garden City, KS shown by years.*

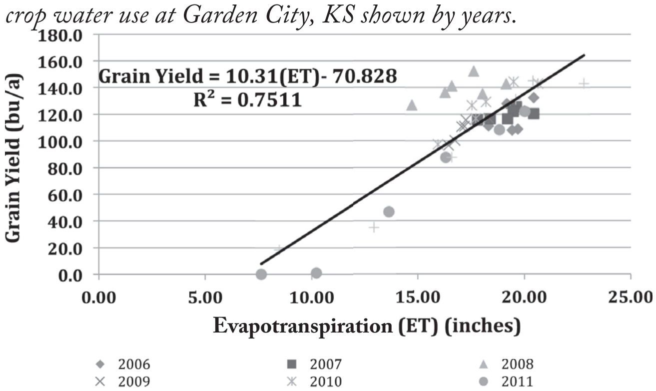


Figure 3. *Yield response of grain sorghum at various levels of irrigation at Garden City, KS shown by years. Years 2006 – 2010 are near average or above precipitation (wet) years. 2011 -2012 are drought (dry) years.*

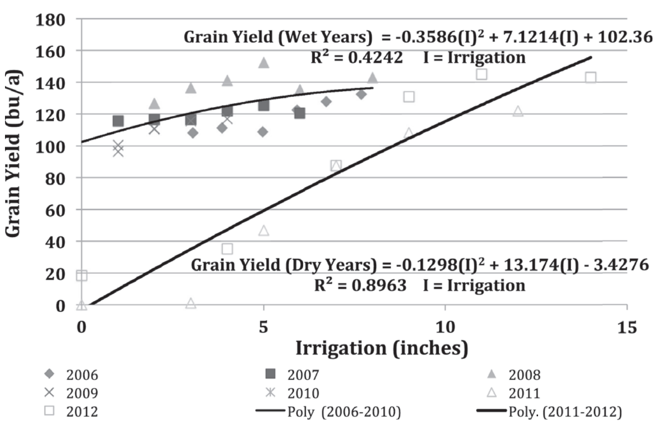


Table 3. *Average water use and grain yield (2001–2008) of grain sorghum as affected by irrigation amount, Southwest Research-Extension Center – Tribune Unit.*

Irrigation Amount (acre-inches)	Seasonal Water Use (inches)	Yield (bu/a)	Water Use Efficiency (lb inch)
5	19.09	94	276
10	22.40	111	278
15	25.44	123	271

Table 4. *Nutrient content of 140 bushel per acre grain sorghum crop.*

Plant Part	Dry Matter	Nitrogen	Phosphorus	Potassium	Calcium	Sulfur	Magnesium
	lb	lb	lb P_2O_5	lb K_2O	lb	lb	lb
Grain	6,780	120	60	30	5	14	10
Stover	7,980	80	16	120	20	12	15
Total	4,760	200	76	150	25	26	25

Fertilizer Requirements

Sorghum is considered extremely efficient in using nutrients from the soil because of its large, fibrous root system; however, profitable responses to fertilization can be expected on many soils. Total nutrient uptake by sorghum is similar to that of corn at comparable yields. Nutrient removal when harvesting only the grain at maturity is lower compared to harvesting the entire crop for silage or forage (Table 4).

Fertilizer and lime needs can best be determined by soil tests with supporting experience and field-history information. Accurate soil tests require knowledge of proper sample collection techniques.

Nitrogen is the most frequently lacking nutrient. Nitrogen recommendations vary with expected yield, soil texture, and cropping sequence.

To use accumulated available nitrogen, use a *profile nitrogen* soil test to reduce applied nitrogen. Take profile samples at a depth of 2 feet. The profile nitrogen test can be particularly useful during drought conditions when potentially large amounts of residual nitrogen can be present in the soil from previous crops. Nitrogen uptake can be limited for failed crops or crops with low yield and growth. Nitrogen not taken up by the crop will likely remain in the soil and can be available for subsequent crops. If plant growth was near normal, however, most of the nitrogen may be in the biomass and not in the soil. In this case, nitrogen will be released after residue decomposition. Cropping sequence is important in determining the optimum nitrogen rate. Legumes grown in rotation with sorghum can provide *nitrogen credits*. For example alfalfa can contribute up to 120 pounds per acre depending on stand age and condition.

Field comparisons of *nitrogen sources* indicate little agronomic difference between sources when properly applied. For no-till or reduced-till systems that leave almost a complete residue cover, inject materials containing urea below the residue to minimize volatilization and immobilization losses. If urea or urea-containing nitrogen is surface applied and not incorporated — or it does not receive 0.25 to 0.5 inch of rainfall or irrigation, ammonia loss might occur. Enough ammonia loss to reduce crop yields can sometimes occur when urea or UAN is applied to a warm, moist soil heavily covered with crop residue. Base nitrogen source on application cost, availability, adaptability to farm operation, and dealer services.

Various *nitrogen application timings* can have equal results for grain sorghum on most soils. Time applications so nitrogen is available when needed for the rapid growth between the five-leaf and boot stages. Preplant nitrogen applications can be made in late fall or spring (except on sandy soils) with little leaching loss. On sandy soils, delay preplant nitrogen applications until spring, sidedress, or split (spring and sidedressed). Make sidedress nitrogen applications no later than shortly after the five-leaf stage.

Active optical sensing systems can predict final yield at 35 to 45 days after planting for more accurate nitrogen recommendations. Producers may want to apply a base level of nitrogen at planting followed by a side-dressed application determined by sensor readings.

Base *phosphorus* applications on a soil test. Consistent responses to phosphorus fertilization generally occur on soils testing very low or low in available phosphorus where yield potential is not restricted by low rainfall. With medium-testing soils, responses have been erratic and normally quite small. Phosphorus applications are recommended on medium-testing soils for their potential yield response and to maintain a highly productive soil. Phosphorus recommendations are shown in Table 5.

Phosphorus can be applied using several *placement methods*: preplant-broadcast, preplant-knifed, or banded at seeding. Starter applications are most efficient when small amounts are applied on soils low in soil test phosphorus. Starter applications can be placed in direct contact with the seed or placed to the side and below the seed. If placed in contact, the starter material should contain no more than 10 pounds of nitrogen plus potash per acre to prevent reductions in germination. Do not place urea or ammonium thiosulfate in direct seed contact.

As with phosphorus, a soil test is the best guide to assess potassium needs (Table 6). Consider additional *potassium* in cropping sequences including forage sorghum. Potassium deficiencies are most likely to be found in clay-pan soils with shallow rooting depths and on sandy soils.

Potassium placements include preplant-broadcast, preplant-knifed, or banded at seeding. The most common potassium source is muriate of potash (potassium chloride); however, potassium sources differ little in potassium availability. Base selection on cost, availability, and adaptability to the farm operation.

Adequate potassium is essential for sturdy stalks. Research shows potassium fertilization reduces lodging on medium- to low-testing soils. Recent research shows adequate chloride may be as important as potassium in stalk strength. Potassium chloride at 40 to 50 pounds per acre supplies adequate chloride. Do not apply high rates of potassium for insurance against lodging. With proper levels of all nutrients, fertilization and good crop-management practices are the best way to minimize lodging.

For many grain crops, *chloride* has been reported to suppress plant disease organisms or improve overall plant health, allowing the plant to withstand infection. Chloride responses have been noted even in absence of disease, suggesting some soils may not be able to supply needed amounts of chloride. Soil test calibration experiments have shown that when soil profile test chloride levels (0 to 24 inches) are less than 45 pounds per acre, responses to applied chloride are likely and may require some chloride fertilizer. Chloride is very mobile in soils, similar to nitrogen.

Lime recommendations are intended to maintain productive soils. Sorghum is not considered the most responsive crop to lime, but do not fail to lime acidic soils. Although yield increases may be small, liming is a sound farming practice. Lime is recommended for sorghum on soils with a pH of 6.0 or less in eastern Kansas and pH 5.5 or less in central Kansas.

Research demonstrates a need for some *secondary nutrients* and *micronutrients* (e.g. zinc and iron) in some

Table 5. *Phosphorus sufficiency recommendations for grain sorghum.*

	Yield Goal, bu/a				
Soil Test P	40	80	120	160	200
(ppm)	Lb P_2O_5/a				
0-5	50	55	60	65	70
5-10	35	40	45	45	50
10-15	20	25	25	30	30
15-20	15	15	15	15	15
20+	0	0	0	0	0
Crop Removal	16	32	48	64	80

Table 6. *Potassium sufficiency recommendations for grain sorghum.*

	Yield Goal, bu/a				
Soil Test K	40	80	120	160	200
(ppm)	Lb K_2O/a				
0-40	75	80	85	90	95
40-80	45	50	55	60	60
80-120	20	20	25	25	25
120-130	15	15	15	15	15
130+	0	0	0	0	0
Crop Removal	10	21	31	42	52

situations, but others are typically not yield limiting. Calcium and magnesium are relatively abundant in most Kansas soils. Liming acidic soils supplies sufficient calcium, and a deficiency of this element would not be expected. Research with boron, copper, and manganese has not revealed consistent responses.

Sulfur may be lacking on sandy soils low in organic matter (less than 1.5 percent). On irrigated sandy soils, sulfur would be of concern only when irrigation water is low in sulfur. Much of the irrigation water in the central Great Plains contains an appreciable amount of sulfur, corroborate levels with a lab test. Current sulfur soil tests, when used alone, are poor predictors of sulfur deficiency. In sandy soils with low organic matter and a low sulfate soil test, try sulfur to ascertain the likelihood of a sulfur response.

See K-State Research and Extension publication *Soil Test Interpretations and Fertilizer Recommendations,* MF2586, for more fertilizer recommendations.

Diseases

Grain sorghum diseases vary in severity from year to year and from one locality or field to another, depending on the environment, pathogens present, and hybrid susceptibility. Estimates of annual sorghum yield losses to disease in Kansas average less than 10 percent.

The eradication of diseases is not economically feasible, so try to minimize losses using an integrated pest management approach. Planting resistant hybrids, providing adequate fertility, and rotating crops help minimize disease losses.

Sorghum diseases of concern in Kansas are listed in Table 7. Of the foliar diseases caused by fungi in Kansas, only sooty stripe and rust cause occasional economic yield loss. Management relies on selecting resistant hybrids and using cultural practices such as crop rotation and the incorporation of residue where no-till is not practiced.

Bacterial leaf diseases have not been shown to cause yield losses in Kansas, but they are generally present in some fields every year, particularly under cool and wet conditions. Management is not necessary.

In addition to sooty stripe and rust, only seedling blights, stalk rots, and grain molds are likely to cause economic yield losses. Crazy top downy mildew and sorghum downy mildew occasionally cause significant yield loss in individual fields or small areas of a field in years with excessive moisture early in the season; this is not a widespread problem. Sorghum ergot infection is rare in Kansas except in hybrid seed production fields. When it does occur, it can cause significant harvesting problems because the sticky honeydew produced can bind up combines, forage cutters, and augers.

Sorghum also is susceptible to many physiological leaf spots. These can be confused with other commonly occurring foliar diseases, so use caution when making a diagnosis. University plant disease diagnostic laboratories can help make positive disease identifications.

See *Stalk Rots of Corn and Sorghum,* L741*; Diagnosing Sorghum Production Problems in Kansas,* S125*; and Sooty Stripe of Sorghum, www.plantpath.k-state.edu/extension/publications/sooty-stripe-of-sorghum.pdf* for specific sorghum disease information and descriptions.

Table 7. *Grain sorghum diseases.*

Seed Rots and Seedling Blights	Pythium Blight Fusarium Blight
Stalk Rots	Fusarium Stalk Rot Charcoal Rot
Foliar Fungal Diseases	Sooty Stripe Northern Corn Leaf Blight Rust Gray Leaf Spot Rough Spot
Foliar Bacterial Diseases	Bacterial Stripe Bacterial Streak
Other	Sorghum Downy Mildew Crazy Top Downy Mildew Sorghum Ergot Grain Molds

Insects

Sorghum insect pests vary from year to year, from different times within the year, from different plant developmental stages, and throughout the state.

The two insects that have caused the most concern to sorghum producers are chinch bugs and greenbugs. Both are usually more problematic to sorghum early in the season, but can be detrimental later, before harvest, especially under less than ideal growing conditions.

Chinch bugs – Adults: black with white wings that form an "x" on their back. Nymphs: reddish orange early, turning gray before molting to an adult. Nymphs have a characteristic transverse white bar across the middle of the body, although it is less distinct in late instars because of the growing wing pads. These insects cause problems annually in Kansas, most often as they suck plant juices from seedling plants when they migrate from senescing wheat to adjacent sorghum fields. Later-season infestations may weaken stalks and reduce berry size and number, especially under dry growing conditions.

Greenbugs – Very small light green aphids with a darker stripe down the middle of the back and antennae the length of their bodies. These aphids are always present in wheat and sorghum fields but are not as prevalent in the past 20 years. Beneficial insects seem to be important in limiting greenbug populations, i.e. lady beetles, lacewings, parasitic wasps.

Sugarcane rootstock weevils – Adult weevils are small, shiny and black, while larvae are small white grubs. Weevils oviposit in seedling stems; larvae tunnel interiorly around nodes and vertically in the stems, which weakens the seedlings, especially in dry conditions. Good early growing conditions mitigate this feeding damage. Early stalk feeding and later infection by stalk rots may result in lodging before harvest.

Ragworms – This is a general term for foliage-feeding caterpillars, which usually occur at or close to the whorl stage. These can be armyworms, fall armyworms, corn earworms, or cattail caterpillars. Leaf feeding can cause concern; however, plants normally recover and no economic consequences are evident.

Headworms – This is a general term for caterpillars feeding in the head, on the berries, from flowering to soft dough. Often they are corn earworms, but also may be fall armyworms, armyworms, or any combination of these. This head feeding generally results in 5 percent loss per worm per head.

Corn leaf aphids – These are dark, blue-green aphids most commonly noticed during the whorl stage when populations are sufficient to produce so much sticky honeydew to retard head extension.

Sorghum midge – Larvae are small orange/reddish maggots feeding directly in the seed between the bracts. The adults are tiny, gnat-like flies that cause concern every year in southeast Kansas and occasionally in south central Kansas. Maggot feeding results in "blasted" head appearance.

Sugarcane aphids – These aphids are whitish or yellowish with black cornicles and feet. They were first detected in Kansas in September 2014. Immigration started early in 2015 and requiring insecticide applications in many fields in July and August, mainly in south central Kansas. These aphids extended through north central Kansas, but fortunately beneficials were quite active and helped control sugarcane aphids as well as other aphids commonly found in sorghum.

For more complete sorghum insect management considerations consult the K-State Research and Extension publications, *Sorghum Insect Management,* MF742*: www.bookstore.ksre.ksu.edu/pubs/MF742.pdf* and *Crop Insects of Kansas,* S152.

Preharvest Dessicants

Because grain sorghum is a perennial species, preharvest desiccation can have several advantages over natural crop drying. For early-planted or early-maturing sorghum, dessication permits an earlier harvest of drier grain. Weeds growing in the crop should be killed, and late-summer weed-seed production may be reduced. Killing the sorghum plant will halt further water use and permit faster rotation to the next crop.

Several chemical desiccants are available for preharvest use. If applied when the grain is physiologically mature, at 25 to 35 percent moisture (black layer), sorghum yields are not adversely affected.

Glyphosate can be used as a defoliant in sorghum grown for feed but not for seed. Glyphosate acts less rapidly than Diquat or sodium chlorate, but is translocated thus more effective in killing the plant. Sorghum seed treated with diquat cannot be used for food or livestock feed.

Following a glyphosate application, there is a minimum 7-day waiting period between application and harvest, but 2- to 3-weeks are common for the plant to be completely killed. Research shows that application of 0.75 pound acid equivalent per acre of glyphosate reduced sorghum grain moisture content 10 percent compared to grain dried under natural conditions. Glyphosate may be applied aerially or on the ground in 3 to 10 gallons of water per acre. Apply with 8.5 to 17 pounds of ammonium sulfate per 100 gallons spray solutions. Because the burn from the nitrogen interferes with the activity of the glyphosate, application of glyphosate in 28-percent urea-ammonium nitrate has not resulted in satisfactory desiccation.

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