K·STATE Research and Extension

Narrow-row Grain Sorghum Production in Kansas

Department of Agronomy **MF2388** **Crop Production**

Row spacings have been of interest in crop production for decades. Yield increases from narrow rows have been attributed to better light interception and more efficient water use. Plant productivity is at its highest near the time the crop closes the canopy, therefore, a crop that closes its canopy earlier in the growing season may have an advantage over a crop with slower canopy development.

Increasing grain sorghum yields by using narrow rows has been studied at Kansas State University at various time during the past 40 years.

Agronomic Considerations for Narrow-row Grain Sorghum

Growing Conditions

Research conducted in eastern Kansas indicated that row-spacing responses depend on the growing condition's effects on yield potentials (Table 1). For the three locations with average yields above 100 bushels per acre, sorghum in 10-inch rows yielded 12 bushels per acre more than in 20-inch rows and 15 bushels per acre more than the 30-inch rows. Yields in the 20-inch rows were only 4 bushels per acre more than in the 30-inch rows, suggesting that the biggest increase comes from very narrow rows.

When moisture stress reduced the yields below 100 bushels per acre, row spacings had less effect on yields (Table 1). When averaged across these locations, yields from all three-row spacings were within 3 bushels per acre.

Considerations for Narrow-row Sorghum

- Greatest yield advantage under high-yield environments (good soil moisture at planting time in western Kansas and highly productive soils).
- Later planting dates typically show yield advantage.
- Select hybrids based on yield, standability, stalk rot and charcoal rot resistance, and stay-green characteristics.
- Weed control can be enhanced because of quick canopy closure.
- Maintain seeding rates similar to those used in wide rows (perhaps increase 10 to 25 percent if using a grain drill or air seeder).
- Grain drills, air seeders, or planters adjusted to narrow-row spacings can be used successfully.
- Conventional, reduced, or no-till seedbed preparation can be used similar to wide rows.
- Cultivation as an alternative for weed control is extremely difficult in rows less than 20 inches wide.
- Use of row-crop head is not possible for harvest in narrow rows.
- Spraying with narrow profile tire sprayers is advisable to minimize traffic injury to sorghum plants.

Studies conducted at Hays in the 1970s reported 9-bushel per acre yield advantage to 12-inch rows compared to conventional 36-inch rows. The advantage of narrow rows was most consistent when planting in mid to late June with seeding rates two to three times higher than the recommended seeding rates. A study conducted at Garden City from 1977 to 1980 found a less consistent advantage to narrow (10-inch) rows compared to wide (30-inch) rows. However, results from individual years did indicate that when subsoil moisture is good before planting, yields from sorghum planted in 10-inch rows at 50,000 to 75,000 plants per acre were equal to, or exceeded, yields from the low-population-wide rows. More recent studies conducted in Garden City and Tribune in 2016 and 2017 compared narrow (7.5- and 15-inch) row spacing to wide (30-inch) rows. The narrow row was planted with a no-till drill and the wide row with a planter. In general, the study showed no yield advantage for narrow row over the wide row planted at the same seeding rate; however, when sorghum was planted late and had hail damage, the narrow row planted at higher population produced higher yield compared to wide row planted at the standard seeding rate (Table 2).

These studies conducted across Kansas found that when growing-season moisture (both subsoil moisture and rainfall) was adequate, narrow rows were more productive than wide rows. When moisture was limited, grain yields were equal across all row spacings. The exception was full-season hybrids planted at Garden City in a continuous

Table 1. *Grain sorghum grain yields for three row spacings in seven environments in Kansas.*

	Location - Years[1]						
Row Spacing (in)	Manhattan[2] 1995	Powhattan[2] 1995	Belleville[2] 1995	Manhattan[2] 1996	Belleville[2] 1996	Manhattan[3] 1997	Wellington[4] 1997
	Grain Yield (bu/a)						
10	137.5	92.1	77.1	122.7	117.9	83.6	77.2
20	115.0	93.4	77.8	119.6	108.8	— —	—
30	115.1	83.8	90.4	113.3	102.5	84.3	79.9
LSD[5]$_{(0.05)}$			12.2			NS[6]	NS[6]

[1]*Planting dates ranged from May 22 to June 6 across all seven environments.*
[2]*Averaged across three plant populations and two hybrids.*
[3]*Averaged across three plant populations.*
[4]*Averaged across two hybrids.*
[5]*LSD Least Significant Difference, used to determine if two means are statistically different.*
[6]*NS—Not significantly different based on the statistical methods used.*

Table 2. *Grain sorghum yield for four narrow-row plant populations compared to a wide row plant population at Garden City and Tribune.*

	Location — Years[1]			
Seeding Rate (Seeds/a)	Garden City[2] 2016	Tribune[2] 2016	Garden City[2] 2017	Tribune[2] 2017
	Grain Yield (bu/a)			
20,000	87	135	43	81
40,000	103	136	49	95
60,000	101	137	61	102
80,000	97	137	67	101
Planted	118	130	49	90
LSD*$_{(0.05)}$	24	NS	11	9

[1]*Planting dates ranged from June 2 to June 12 across all four environments. Averaged across three nitrogen rates.*
[2]*In 2016 plots were seeded at rates of 27,000, 40,000, 54,000 and 68,000 seeds per acre on 7.5-inch row spacing using 40-foot farm-size air seeder, while in 2017 plots were seeded at rates of 20,000, 40,000, 60,000, and 80,000 seeds per acre on 15-inch row spacing using a 40-foot John Deere Experimental Sorghum drill at the Garden City location. At Tribune, plots were drilled at 20,000, 40,000, 60,000, and 80,000 for both years. Sorghum was planted using a planter at 27,000 seeds per acre in 2016 and 20,000 seeds per acre in 2017 at the Garden City location. At Tribune sorghum was planted at 40,000 seeds per acre in both years.*

sorghum system with little stored soil moisture at planting. Under these conditions, the low population, wide-row spacings produced higher yields.

Sorghum's drought tolerance reduces the risk of narrow-row grain sorghum production in Kansas. In high rainfall years or on highly productive soils, narrow rows produce higher yields than conventional row spacings; however, in most low-yielding environments, narrow rows produce grain yields similar to wide rows. This enables producers to adopt narrow rows in most sorghum producing situations.

Tillage systems

Adapting narrow rows to either conventional, minimum, or no-tillage systems is certainly possible if key issues are considered. The management difference between the tillage systems deals primarily with pest control and nutrient placement. In most scenarios, pest management strategies that work under a given tillage system work in narrow rows in that tillage system. Herbicide and insecticide application equipment for narrow rows are discussed in the Machinery Considerations section. One consideration from a disease standpoint for narrow-row sorghum production using no-till would be selecting a hybrid with good resistance to sooty stripe. Sooty stripe is a fungal disease in which the growing crop is infected from spores that overwinter on sorghum residue from the previous year's crop. The disease spreads rapidly when the relative humidity in the crop canopy is high. The quicker developing canopy of narrow-row sorghum may increase the spread of the disease in a high-residue system.

Consider the placement of fertilizer in a no-till system when adopting narrow-row grain sorghum production. For the most part, the nitrogen application methods used in each tillage system under wide rows work adequately in narrow rows; however, the placement of phosphorous fertilizer may be a greater challenge in narrow rows. If a producer is currently applying phosphorous fertilizer with the planter in a band with the seed, this can also be accomplished with a grain drill fitted with fertilizer tanks or boxes. Narrow rows also have the advantage when placing fertilizer with the seed in that the recommended rate of nitrogen containing fertilizer can increase from 10 pounds nitrogen per acre to 15 or 20 pounds nitrogen per acre (depending on narrow-row spacing) since the fertilizer concentration in a given row is reduced as more rows are planted. If a producer is currently applying phosphorous fertilizer in a band next to the planted row (2 × 2 placement), then fertilizer placement shanks can be used to achieve the same type of placement on a grain drill.

Planting Date Considerations

The ability of narrow rows to quickly develop a canopy makes it advantageous for later planting dates. When planting is delayed as a result of weather conditions or grain sorghum is being double-cropped after wheat, consider using narrow rows to increase grain yields. In western Kansas, delayed planting also allows more soil moisture to be stored for the sorghum crop and time to control additional flushes of weeds.

Seeding Rates and Hybrid Selection

Grain sorghum adapts to the conditions it is grown under by producing more heads per plant (tillers) and more seeds per head, and by increasing seed weight. Research studies indicate that sorghum yields in eastern Kansas are maximized as long as plant populations of more than 40,000 plants per acre are achieved. This yield response to plant populations was consistent regardless of row spacings in studies conducted in 1995 and 1996 in northeast Kansas (Table 3).

Table 3. *Two-year average grain sorghum yields for three plant populations at Belleville and Manhattan.*

Plant Population (plants/acre)	**Belleville**	**Manhattan**
	Grain Yield (bu/acre)	
30,000	101	117
60,000	106	122
90,000	107	120
$LSD_{(0.05)}$	NS	NS

In western Kansas, subsoil moisture and hybrid maturity needs to be considered when selecting a seeding rate. When subsoil moisture is adequate (after a fallow period or above-average winter rainfall), research indicates that seeding rates for narrow rows can be set to achieve final stands of 50,000 to 75,000 plants per acre if early to medium-maturing hybrids are used. If narrow-row sorghum is planted in a continuous sorghum cropping system or if a full-season hybrid is being used, use typical seeding rates of 20,000 to 50,000 seeds per acre. In late-planted sorghum, the increase the seeding rate to achieve a final stand of 50,000 to 75,000 plants per acre.

When selecting a hybrid for grain sorghum production in narrow rows, grain yield should be the primary focus. After selecting hybrids for yield potential, standability should be a secondary concern. Standability is important since harvesting lodged plants in a narrow-row production system is more difficult compared to conventional row spacings. Scrutinize a hybrid's ratings for standability, stalk rot and charcoal rot resistance, and stay-green ratings. These ratings give a producer indications of a hybrid's ability to stand under adverse growing and harvesting conditions.

Weed Competition and Weed Control

Light interception advantages of narrow-row sorghum systems offer weed control advantages over wider rows since early canopy closure reduces the number of weeds that emerge during the growing season. Research conducted at Kansas State University indicated the growth of weeds that did emerge was reduced in the 10-inch rows by 24 percent compared to the 20-inch rows and by 45 percent when compared to the 30-inch rows. Under heavy broadleaf weed pressure, the 10-inch rows produced 6 bushels per acre more grain than the 20-inch rows and 31 bushels per acre more grain than the 30-inch rows.

Since cultivation is not possible, herbicides are required for in-season weed control in narrow rows. For control of grassy weeds, soil-applied herbicides are

Figure 1. Emergence of drilled and planted sorghum. A) Sorghum planted using a no-till air seeder drill. B) Sorghum planted using a standard 30-inch planter.

A) Nonuniform emergence: Plants emerged 15 days after planting.	B) Uniform emergence: Plants emerged 3 to 5 days after planting.

currently the most reliable option for grain sorghum in the absence of cultivation. Postemergence herbicide selection and timing should not be different than those used in wide rows.

Machinery Considerations for Narrow-row Grain Sorghum

Growing narrow-row grain sorghum does not require equipment changes for most growers. There are, however, some items for growers to consider when planting sorghum in narrow rows. For this discussion, equipment considerations is divided into planting, crop management, and harvesting.

Planting

Growers have three basic options for planting narrow-row grain sorghum: drills, air seeders, and split-row planters. Since most growers have a grain drill, this is an easy option; however, setting the seed metering rate low enough may be a problem. Check the calibration charts in the operator's manual to determine the proper settings. Remember, this is a starting point; check the calibration after a known acreage is seeded. Make sure seeding depth is set correctly and good seed to soil contact is obtained when using a drill. Keep in mind, establishment rates with a drill are often lower than with a planter, so seeding rates may need to be increased 10 to 20 percent to achieve similar plant populations as achieved when using a planter.

Air seeders, another option for seeding narrow-row crops, were popular in Kansas a few years ago, but that popularity had declined. New styles of air seeders have led to resurgence in popularity. These air seeders include better metering and different options for openers, including some disc models. The better openers allow for better seed placement. Air seeders are typically wide, resulting in greater seed capacities than most grain drills. They also are versatile enough to plant many different crops in a wide range of conditions. The main disadvantage of air seeders is their initial cost. Air seeders also can have similar establishment problems as drills. Figure 1 shows an establishment problem observed when using an air seeder seeding at the same rate as a planter; yields can be reduced by as much as 35 percent. To avoid yield loss, increase seeding rates to achieve plant populations similar to a planter.

Using a split-row planter, a planter that has row units positioned to split the middles of the conventional row spacing allowing for planting in narrow rows, results in a more uniform stands than a grain drill as planters give better seed to soil contact than most drills and tend to provide more uniform stands. Split-row planters achieve better seed metering than a grain drill at the lower seeding rates typically used for grain sorghum. The main disadvantage of split-row planters is initial cost, but they do have the advantage that they can be used to plant other crops such as corn or soybeans in narrow rows. Result using a split-row planter found no difference in yield between narrow row (15-inch) and wide row (30-inch) planted at the same seeding rate (Figure 2).

Crop Management

Crop management machinery includes sprayers and row-crop cultivators. A row-crop cultivator may not be an option for most row spacings less than 15 inches. Some growers with 20-inch rows are still cultivating. Cultivating 20-inch rows requires significant changes in the cultivator and possibly tractor tire setup and width.

Applying postemergence herbicides on narrow-row grain sorghum with a ground applicator may present challenges. It is possible to drive between 20-inch rows, but narrower rows can be a problem. Consider spraying perpendicular to the planted rows in a crop planted with a drill or 15-inch planter. If you are considering

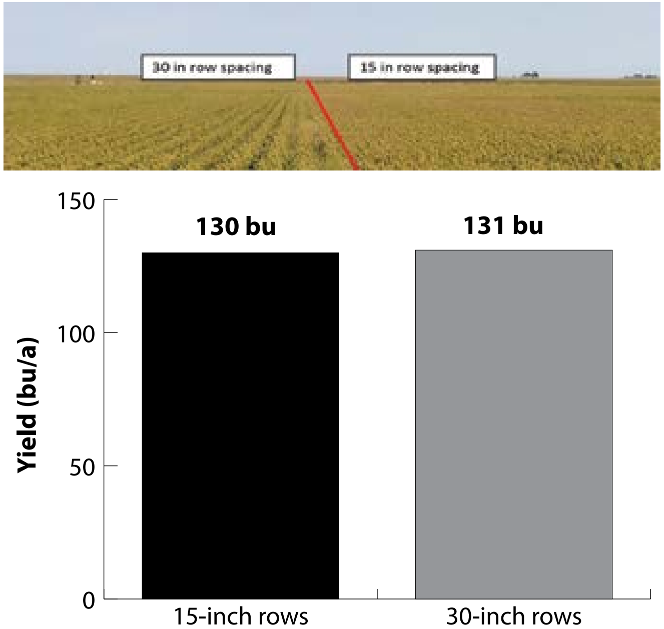

Figure 2. On-farm replicated trial showing the effect of row spacing on sorghum yield for sorghum planted at the same population.

this option, use the widest possible boom since a wider boom maximizes the area sprayed compared to the area being driven over. A high clearance sprayer with 18.4-inch tires drives on 10 percent of the area sprayed when the sprayer is equipped with a 30-foot wide boom. A sprayer with the same tire setup and a 60-foot boom only drives on 5 percent of the area being treated. Most postemergence herbicide labeled for sorghum have an 8- to 12-inch plant height restriction, limiting most application to the early portion of the growing season. Plant damage from tire traffic has little or no effect on final grain yields due to sorghum's ability to compensate by increasing head number or seed number per plant in the trafficked areas.

Harvesting

If you are accustomed to harvesting sorghum with a row-crop head, expect some changes when converting to or trying narrow-row sorghum. A grain platform with harvest attachments can be quite effective in standing sorghum. The attachments are fixed to the cutter bar and extend forward to help keep heads from falling out of the header. Attachments are available from several manufacturers and greatly improve harvest efficiency in standing crops. Performance may be reduced in a lodged crop. Lodged crops can be harvested with a flex head and pick-up reel.

Summary

Narrow rows may produce higher yields than conventional row spacings in highly productive environments, later planting dates, and in an environment with high risk of hail damage while not exposing producers to additional risk in more marginal environments. Sorghum's ability to adjust head number and seed number per plant provides producers with great flexibility when deciding seeding rates; however, when planting narrow row sorghum, consider planting equipment capability and planting date when deciding to alter seeding rates. Choose high-yielding hybrids with exceptional standability, stalk rot resistance, and stay-green ratings to reduce the risk of lodging. Sorghum planted in narrow rows can reduce weed competition. A chemical weed control program should rely on preplant or preemergence soil herbicide applications followed by an early postemergence herbicide application if needed.

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