Irrigation Scheduling for Grain Sorghum

KEY POINTS

- Water stress can significantly affect grain sorghum yield potential; the extent of yield loss depends on the growth stage at which the stress occurs.
- The most critical period to avoid water stress is from about one week prior to the emergence of the grain head from the boot (exertion) through two weeks past flowering.
- To preserve yield potential, it is important to monitor soil moisture and apply irrigation when soil moisture is depleted, especially during critical water use periods.

Figure 1. Sorghum plant with poor exertion because of minor drought stress.

Characteristics of Grain Sorghum

The extensive and fibrous root system of a grain sorghum plant (which can extend to depths of 4 to 6 feet) allows it to withstand drought conditions better than corn. When drought stress occurs in grain sorghum, the growth stage of the plant will have a strong impact on the potential for yield loss (Table 1).

Table 1. Potential reduction in yield from moisture stress*

Growth Stage	% Yield Reduction
Emergence to V8	10 - 15
Boot to flowering	30 - 50
Soft dough to maturity	10 - 20

*2013 Arkansas grain sorghum quick facts, University of Arkansas

Sorghum Water Use at Different Growth Stages

The total water usage (soil evaporation and plant transpiration) to produce a sorghum yield of 7,000 lb/acre has been estimated to be about 28 inches of water/acre.[1] However, total water usage can vary by product maturity, planting date, environmental conditions, and final yield. Daily water usage varies by growth stage (Table 2, page 2).

Planting to early growth. During early growth (germination to 6 mature leaves), water use is relatively low; however, stress at this time can affect future growth, plant size, and yield potential. After seedling establishment, water use by the plant increases sharply. While in the rapid growth phase, the seed panicle and the number of ovules that can potentially develop into seeds are forming within the stalk. Any water shortage during this developmental stage can be detrimental to yield potential and overall plant health.

Early reproductive stage. The most critical period to avoid water stress is from about one week prior to the emergence of the grain head from the boot (exertion) through two weeks past flowering. During this time, plants suffering from severe drought may not be able to push the grain head out of the boot (Figure 1). The plant needs about 0.2 to 0.3 inch of water/day during this phase. About 8 to 10 inches of water (if available) will be consumed by bloom.

Reproductive stage through maturity. The reproductive phase begins with bloom and lasts about 45 days until physiological maturity or black layer. About 0.3 inch of water/day will be used by the plant from just before bloom until early grain fill. Additional water after maturity will not

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add weight to the seeds, but may help with stalk integrity if conditions are extremely dry.

Irrigation Timing

In general, soil moisture levels should be used to dictate when irrigation should be applied. If irrigation water is limited, farmers should consider the growth stage of the crop and reserve the water for the most critical stages.

Tools to Help Determine Soil Water

Tools available to help determine soil water range from simple soil probes to soil moisture sensors and sophisticated web-based applications that have access to soil databases and weather networks.

- Soil moisture sensors can be installed at 1-, 2-, and 3-foot depths to measure soil moisture. The sensors should be located within the crop row and not placed into low areas.
- Soil moisture can be tracked by measuring water inputs from precipitation and irrigation and estimating losses from evapotranspiration (ET). Some states have web-based ET calculators to help determine water usage, needs, and availability.
- Though less precise, soil probes are another means of measuring soil water and compaction. If the probe cannot penetrate the surface, there is no subsurface moisture. Prior to sorghum boot stage, the probe should be able to be pushed to a depth of 3 to 4 feet, which indicates there is about 4 to 6 inches of stored water depending on soil type. During heading, flowering, and grain fill, the probe should go to a minimum depth of 8 to 10 inches. After black layer, a probe depth of at least 6 to 8 inches indicates that moisture is sufficient to retain stalk integrity, even though water is no longer needed for seed fill.[4]

Managing Soil Moisture

The use of conservation tillage and residue management can help preserve soil moisture during early crop development when the soil is exposed.

Available moisture is an important factor in determining sorghum row spacing and planting population. A soil-shading canopy can develop quicker with narrower rows, which can help decrease the loss of soil water through evaporation.

Water use increases with higher populations because more plants are drawing upon soil water reserves; therefore, lower populations may be needed when water is limited.

General Irrigation Strategies

A general full-irrigation strategy from Texas A&M University is outlined below:

- Assuming the soil water profile is adequate to full at planting, additional water should not be necessary until the reproductive stage begins.
- At the beginning of the reproductive stage, a 4-inch irrigation can last until the flag leaf appears.
- Two 3-inch irrigations about two weeks apart at flag leaf or boot stage should carry the plants to the soft dough stage of kernel fill.
- A 3- to 4-inch irrigation at soft dough stage should be able to carry the crop to maturity.[1]

Several rules-of-thumb for determining the final irrigation include:

Arkansas information suggests terminating furrow irrigation when > 50% of the heads are at hard dough and soil moisture is adequate and terminating pivot irrigation when > 75% of the heads are at hard dough and soil moisture is adequate.[2]

Table 2. Estimated grain sorghum water use by growth stage*

Days After Planting	Inches/Day
0 - 30 (early plant growth)	0.05 - 0.10
30 - 60 (rapid plant growth)	0.10 - 0.20
60 - 80 (boot and flowering)	0.25 - 0.30
80 - 120 (grain fill to maturity)	0.25 - 0.10

*2013 Arkansas grain sorghum quick facts, University of Arkansas

Sources: [1] Stichler, C. and Fipps, G. 2003. Irrigating sorghum in South and South Central Texas. L-5434. Texas A&M University. [2] Klocke, N.L., Eisenhauer, D.E., and Bockstadter, T.L. 1991. Predicting the last irrigation for corn, grain sorghum and soybeans. NebGuide. G82-602-A. University of Nebraska. [3] Kelley, J. and Lawson, K. 2013 Arkansas grain sorghum quick facts. University of Arkansas. [4] New, L. 2004. Grain sorghum irrigation. PROFIT. B-6152. Texas Cooperative Extension. The Texas A&M University System. Other source: Stichler, C., McFarland, M., and Coffman, C. 1997. Irrigated and dryland grain sorghum production, South and Southwest Texas. Texas A&M University. 150410115543