Grain sorghum (Milo) Production in Kentucky

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Cultural Practices

Site Selection

Grain sorghum can be produced on a variety of soils. It is a drought-tolerant plant that can be grown on shallow, less productive soils with low water-holding capacity. In these environments, grain sorghum yields can be better than corn yields, although typically they equal corn yields. The advantage of grain sorghum in these environments is that it can be more profitable than corn because fewer inputs are required.

Grain sorghum yields increase as the soil productivity and water-holding capacity increases. On highly productive, deep soils with high water-holding capacity the yield potential for grain sorghum is greatest. Grain yield of corn in these environments is also high, which results in corn profitability exceeding grain sorghum profitability.

Figure 1. Grain sorghum (Sorghum bicolor)

Grain sorghum (Sorghum bicolor) (Figure 1) can be used for a variety of purposes including animal feed, unleavened breads, cakes, wallboard, starch, dextrose, brooms, ethanol, high quality wax, and alcoholic beverages. Grain sorghum produced in Kentucky is most commonly used for animal feed and was first grown here in the 1920s. Although acreage in Kentucky has fluctuated considerably over the years, yields have generally exceeded the national average since the 1970s (Figure 2), indicating that grain sorghum is an option for producers interested in diversifying grain crop operations.

Figure 2. Grain sorghum acreage and yield in Kentucky from 1924 to 2012 and average national yield from 1934 to 2012.

Source of data: USDA-NASS (www.nass.usda.gov)
Hybrid Selection

Potential yields, maturity, stalk strength, and disease resistance should be considered when selecting a grain sorghum hybrid. As with any crop, a hybrid with high yield potential is always desired. Full season maturity hybrids are preferred for their high yield potential compared to short-season hybrids, assuming the crop is planted in May. If planting is delayed into June, especially mid-June or later, a short-season hybrid should be considered. Selecting hybrids with low lodging scores (high stalk strength) is important because this indicates the hybrid is less likely to fall over in stress environments. Anther stalk rot (the primary stalk rot disease) and charcoal rot resistance are also very important to help reduce the risk of lodging.

Good seeding vigor and physical characteristics such as head exsertion and head type should also be considered when selecting grain sorghum hybrids. Head exsertion is the distance between the sorghum head and the top leaf (Figure 3). Head exsertion can vary from 0 to 8 inches. At harvest maturity, leaves near the top of the plant may still be green. Heads with little to no exsertion will require a desiccant before harvest.

There are three head types: compact, semi-compact, and open. Compact head types may be more susceptible to head diseases and insect pests. Insects may be more difficult to scout and treat when the top leaf is in contact with the head. Heads are more difficult to scout and treat when the head is in contact with the top leaf. The close proximity of grain to the top of the plant may still be green. Heads with little to no exsertion will require a desiccant before harvest.

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Sorghum seed can be planted when soil temperatures at 3 inches are at least 65°F. Grain sorghum seed germinates rapidly when soil temperatures are 65°F and warm weather is expected after planting. In Kentucky, sorghum yields are typically greatest when the crop is planted from May 1 to June 1. When planting window insect pests are less damaging, adequate rainfall during vegetative stages typically occurs, and lower soil moisture levels during the growing season (mid-July) can reduce head diseases. Later planting dates are very common in Kentucky and result in lower yields and higher grain moisture at harvest. If grain sorghum is planted after the preferred hybrid is selected, adequate moisture must be available at seeding for soil seed germination and seedling establishment. It also allows more time for scouting for sorghum weevils and fall armyworm. Short-season hybrids are preferred when planting sorghum late.

Seedling emergence

Seeds and seedling treatments such as Concel N® (fluoxfenin) and Screen® (fluridone) greatly increase the number of germinants that can be safely used in grain sorghum production. Weed control is discussed below. Several fungicide and insecticide seed treatments may also be used to protect against seed and seedling diseases and insect pests. Select from nearby states, such as Missouri, recommended using fungicide seed treatments for grain sorghum if planting early into cool or poorly drained soils or if planting late so that seedlings will be emerging and secondary roots developing during periods of high temperatures. Grain sorghum insecticide seed treatments are essential for most of the deep south regions. In Kentucky insecticide seed treatments likely are not necessary unless plantings occur mid-June or later or if sugarcane aphid becomes an established problem, problematic pest or an annual migrant pest in Kentucky. Sugarcane aphid was verified in Kentucky in 2015; however, the implications of this finding are unclear at this time.

Planting Date

Grain sorghum seed germinates rapidly when soil temperature is above 70°F. Grain sorghum seed can be planted when soil temperatures are 65°F to 67°F and warm weather is expected after planting. In Kentucky, sorghum yields are typically greatest when the crop is planted from May 1 to June 1. Within this planting window insect pests are less damaging, adequate rainfall during vegetative stages typically occurs, and lower soil moisture levels during the growing season (mid-July) can reduce head diseases. Later planting dates are very common in Kentucky and result in lower yields and higher grain moisture at harvest. If grain sorghum is planted after the preferred hybrid is selected, adequate moisture must be available at seeding for soil seed germination and seedling establishment. It also allows more time for scouting for sorghum weevils and fall armyworm. Short-season hybrids are preferred when planting sorghum late.

Row Spacing

Grain sorghum is produced in various row spacings, which can be dictated by equipment type and yield. Row spacing studies in Missouri and Illinois have not produced consistent results. In general, as row spacing narrows the rows or canopy closure and competition with weeds should decrease. In addition, grain sorghum produced in 15 or 7.5-inch rows usually has less of a problem with plant lodging. Most of the grain sorghum produced in Kentucky is planted in 15-inch rows. Although the data are preliminary, it appears that narrower row spacings may help control sugarcane aphid.

Planting Depth

Typical planting depths range from ½ inch to 1 inch. Depths of about ½ to 1 inch should be considered early in the season when soils have adequate moisture and soil temperatures are around 60°F to 65°F. Depths of 1 to 1½ inches can be considered later in the season when soil temperatures exceed 70°F and palisade sheaths have removed the upper ½ inch of soil. Grain sorghum planted deeper than 1½ inches may not emerge or will emerge very slowly.

When adjusting planting depth it is very important to make sure that adequate seed-to-soil contact is achieved to ensure emergence success. Make sure that the furrow is covered and closed. Open furrows will greatly reduce seed-to-soil contact, which can delay seedling emergence.

Plant Population

Plant populations are very important because too high populations can cause lodging and reduce yield while too low populations can result in large populations of weeds and lower grain yield. A seeding rate of 60,000 seeds per acre should result in adequate yields for Kentucky. However, seeding rate recommendations range from 50 to 125 pounds N per acre. It is always best to collect soil samples well in advance of planting to allow sufficient time for field development. The Kentucky Department of Agriculture recommends the following guidelines for nitrogen recommendations:

- 0 to 11.5 inches: 0 to 125 pounds N per acre
- 11.5 to 20 inches: 125 to 250 pounds N per acre

For exact nitrogen recommendations based on soil test results and the most current version of the ASM guidelines, visit the ASM website at http://www.ksre.ksu.edu/pubs/sites/13/pdf/MP297/MP297.PDF. Nutrient Management

As with most crops, grain sorghum requires proper nutrient management for maximum yield. It is always best to collect soil samples well in advance of planting to allow sufficient time for field development. The ASM guidelines specify 11.5 to 20 inches: 125 to 250 pounds N per acre

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spacings, and possibly be shorter and more erect than normal. Phosphorus deficiency is typically noticed in younger (upper) leaves first and will move down the plant to older leaves as symptoms progress.

**Weed Control**

Weed control in grain sorghum can be challenging. First, there are a limited number of herbicides that are labeled for use in grain sorghum. Many of the labeled herbicides are selective, which means they control only specific species. In general, most postemergence herbicides are labeled for use on very small weeds, which makes scouting very important in grain sorghum production. To achieve the highest possible grain sorghum yield, fields with low weed pressure should be selected. Fields infested with johnsongrass (Sorghum halepense) or shattercane (Sorghum bicolor) should be avoided. Because these are closely related plant species, chemical control is difficult. In addition, johnsongrass can harbor plant pathogens and insect pests that can negatively impact grain sorghum yields.

In conventional tillage systems the best options for weed control are field cultivation and chisel plowing followed by herbicide applications. In no-till production systems weed control programs that include herbicides for “burndown” of existing vegetation are crucial. For the most updated herbicide options for grain sorghum production consult AGR-6 Chemical Control of Weeds for Kentucky Grain Crops (http://www2.ca.uky.edu/agc/pubs/agr/agr6.htm).

**Harvest Aids**

Some chemicals such as glyphosate or sodium chloride are labeled for applications prior to harvesting grain sorghum. These allow for a more timely harvest of the crop and limit yield losses due to lodging, birds, insects, diseases of the head, and weather. These treatments desiccate (kill) living grain sorghum tissue, help control weeds, and allow harvest to occur more quickly than if not applied. These should be applied only after the grain sorghum has reached physiological maturity and seed moisture content is less than 30 percent. Follow the label for preharvest interval (i.e., time between chemical application and grain harvest) and avoid harvest delays after the preharvest interval in order to avoid stalk decay and lodging. Note that harvest aids or desiccants may enhance lodging in fields infested with charcoal rot.

**Insect Management**

Insect management is essential when producing grain sorghum in Kentucky because there are several insect pests that can negatively impact grain sorghum yield and quality. Insect pests are generally divided into two groups: those that affect the grain directly and are indirect feeders, and those that feed on the leaves and stalks and generally reduce the vigor of the plant and the flow of nutrients to the grain heads.

The most common insect pests of grain sorghum seedlings and plants are aphids. Greenbug, corn leaf, yellow sugarcane, and—beginning in 2015—sugarcane aphids can be found in Kentucky-grown grain sorghum. These pests have piercing sucking mouth parts with which they suck the sap from plants. Their digestive systems are somewhat inefficient, which results in their defecation of large amounts of a sticky, sugar-rich liquid called honeydew. Honeydew coats the leaves and stalks leaving them sticky, which can interfere with harvest and support the growth of a black-colored ‘sooty mold’ which can cover the leaves and disrupt photosynthesis. Historically, aphid damage is rarely significant. Yellow sugarcane aphid (YSA) and sugarcane aphid (SCA) are pests of grain sorghum in the deep south, and both can occur in Kentucky. YSA is a native insect found over the American South and Midwest. SCA is a non-native invasive species that appears to be unable to survive the winter as far north as Kentucky. Typically significant damage has not been reported from any of the aphids, though it may be too early to know how SCA will fit into Kentucky’s production system.

Currently SCA is expected to be an annual migrant moving from Texas/Louisiana northward each year. The timeliness of planting and thus grain maturity and the variable annual arrival date of SCA will likely vary from year to year making it difficult to predict in what years the pest will be a problem. This variability magnifies the need for scouting early and often. In 2015 some grain sorghum fields were sprayed, largely to prevent gummy gum up combines with honeydew. Populations in some fields were greater than the 0.1 to 0.2 aphids per leaf for a 50-leaf sample and were treated, but most of these fields were near maturity and untreated. In Kentucky SCA was found as far east as Allam County and as far north as Henderson County. In addition, several counties in southern Illinois at least as far north as the latitude of Henderson, Kentucky, were known to be infested.

There are still many unknowns about SCA as it is not well studied outside of Texas and Louisiana. Those interested in grain sorghum production are advised to consult Kentucky Pest News (http://www2.ca.uky.edu/agccollege/plantpathology/extension/kp/index.htm) and the Grain Crops Update Blog (http://graincrops.blogspot.com/) often as information on incidence, scouting, thresholds, and pesticides are likely to change very quickly.

Chinch bugs, another piercing sucking feeder, may also be found in Kentucky. Though this pest has been quite rare, it is very destruc
tive when present. In Kentucky chinch bug is generally associated with late planting and drought conditions. They can infest at any plant stage during the season but have been important in Kentucky only in the seedling stages.

Insect pests that feed directly on the grain head are most likely to result in economically impor
tant damage to grain sorghum. Sorghum midge and the “head worm complex” comprised of fall armyworm, corn earworm, and sorghum webworm feed directly on the grain. In addition, their excrement and moisture, as well as silk from the webworms, can reduce the grain quality and result in storage problems.

Sorghum midge, a very small fly, only attacks grain sorghum in the late-bloom phase. This fly lays its eggs in the open bloom and the resulting maggots feed on the developing grain from the inside. Protection from this insect can only be insured by killing the adult fly so that she cannot lay her eggs in the bloom. Insectic
dide application at any other time is of no use. Furthermore, caterpillars of the head worm complex feed on the developing grain after bloom. These insects can be seen and thus counted and recorded to determine if control is necessary. Early maturiation of sorghum will help avoid problems with the sorghum midge and the head worm caterpillars.

Scouting and identification of grain sorghum insects, including economic thresholds for each insect pests, is dis
Insect control can be achieved through both cultural practices and chemicals. Planting date has a huge impact on potential damage by specific insects. Planting sorghum too early (before soil temperatures reach 62° to 70°F) can result in greenbug and chinch bug infestations while late plantings (June 1 and later) will increase problems with sorghum midge, the head worm complex, and likely SCA. In a given field a single planting date and uniform head emergence and head maturation are important in reducing the risk that insects will move from earlier to later developing plants. Effective johnsongrass control is also essential because it serves as an alternate host for all of the aphids and many of the other pests. Chemical control options may be necessary even with good cultural practices. For current recommendations for insecticides refer to ENT-24: Insecticide Recommendations for Grain Sorghum (Miss). [http://pest.ca.uky.edu/ENT/Ents/ENT24_Sorghum.pd](http://pest.ca.uky.edu/ENT/Ents/ENT24_Sorghum.pdf).

### Diseases
#### Seed and Seedling Diseases

**Root Rot**

**Cause:** Periconia, Pythium, Rhizoctonia, Fusarium

**Symptoms:** Stunted plants that are some times wilted and have pale green or yellow leaves. Roots can be soft and/or pink, reddish brown, or black instead of white and firm. Severely damaged plants will die. Surviving plants can be weak, unproductive, and more susceptible to other diseases and environmental stresses.

**Key Features of Disease Cycle:** The fungi that cause root rots are common in all soils and typically do not cause damage unless the plant is stressed. Common stresses include cool soils, poor drainage, or inadequate fertility. Healthy, vigorous plants can produce new roots to compensate for damaged roots. Stressed plants cannot easily produce new roots and are more likely to succumb to root rots.

**Management:** Plant high quality seed of adapted hybrids. Plant seed into moist soils, which are preferably 70°F in the top 2 inches of soil. If seed is planted when soil is below 70°F consider using seed that is treated with a broad-spectrum fungicide. Plant into fertile soils that have a pH of 6.0 to 6.5. Fusarium is more likely to infect plants when soil pH is low (around pH 5.8). Avoid stressful environments such as poorly drained fields and excessively high plant populations and ensure proper fertilization and pesticide applications to avoid stress and/or injury to seedlings. Fungicide seed treatments and in-furrow fungicide applications at planting may provide protection against root rot pathogens for a few weeks after planting but will not provide season long control.

#### Leaf Diseases

**Maize Dwarf Mosaic**

**Cause:** Maize dwarf mosaic virus (MDM)

**Symptoms:** The characteristic MDM symptom is leaf mottling where leaves turn yellow with light green islands. Mottling is more apparent on young leaves than older leaves. Leaves can also turn red followed by elongated tan stripes with red margins when growing temperatures fall below 55°F. Mottling is less visible at the boot growth stage. Most plants will survive infection but can be stunted and produce abnormal heads, severely infected plants may die.

**Key Features of Disease Cycle:** Some strains of the virus may overwinter in johnsongrass rhizomes. Aphids and greenbugs may acquire the virus by feeding on infected johnsongrass and then transmit the virus when they feed on sorghum or other susceptible plants such as rice. Late planted sorghum is at a greater risk of MDM because the insect vectors are in greater numbers later in the season.

**Management:** Insecticide treatments do not provide high levels of control of this disease. The best control of MDM is achieved when resistant hybrids are planted and when johnsongrass and other perennial grassy weeds are controlled.

**Fungal Leaf Blights and Spots**

**Cause:** Exserohilum, Bipolaris, Cercospora, Gloecocercospora, Ascochyta, Ramulispora, Puccinia, Helminthosporium, Colletotrichum

**Symptoms:** Fungal leaf blight and spots and their characteristic symptoms are presented in Table 2.

**Key Features of Disease Cycle:** With the exception of the sorghum leaf rust fungus (Puccinia purpurea), most fungi that cause leaf blights and spots survive in crop residue. Spores are spread by wind and splashing rains. In severe cases when upper leaves are infected yield may be reduced, but in most cases these diseases cause minimal yield losses.

**Management:** Use resistant hybrids and rotate fields out of sorghum and corn for one to two years. Controlling grassy weeds can also eliminate potential inoculum sources. Foliar fungicides will provide some protection against most foliar diseases.

**Bacterial Leaf Blights and Spots**

**Cause:** Bacillithorula, Xanthomonas, Pseudomonas

**Symptoms:** Bacterial leaf blight and spot diseases and their characteristic symptoms are presented in Table 2.

**Key Features of Disease Cycle:** Bacteria overwinter in infected plant debris and can be spread in seed. Spread of bacteria can occur by wind, splashing rain, and insects. Bacterial diseases are most severe when temperatures are warm (75° to 80°F) with high moisture. Bacterial diseases generally cause little economic damage.

**Management:** Purchase high quality, certified seed and use resistant hybrids. Limiting grain sorghum production in a field every third year and controlling weeds, especially shuterame (Sporisorium), will reduce bacteria.

**Stalk Rots**

**Charcoal Rot**

**Cause:** Macrophomina phaseolina

**Symptoms:** The stalk feels spongy, and when stems are cut lengthwise the interior will be shriveled and discolored because the fungus decomposes the pith tissue. Plants often lodge. Small, pin-sized black fungal structures (microsclerotia) may be observed in affected crown and stalk tissues.

**Key Features of Disease Cycle:** Charcoal rot fungus survives the winter in soil and crop residue.

**Management:** Use resistant hybrids with good stalk strength, avoid excessive plant populations, maintain proper fertility, and reduce drought stress with irrigation where possible.

**Smut**

**Cause:** Sporisorium spp.

**Symptoms:** At heading masses of dark, powdery spores replace grain. Stalks often chemically treated seed controls these diseases. Using high quality, certified seed of resistant hybrids is the most effective control of sorghum smut.

**Head Blight**

**Cause:** Fusicoccum spp.

**Symptoms:** Cream to pink fungal growth occurs on grain and can spread to infect the stalk at and immediately below the head. **Key Features of Disease Cycle:** The fungus spreads through seed and on crop residue. Warm, moist conditions promote disease development.

**Management:** Thicly harvest at proper moisture levels and reduce disease pressure. Hybrids with pigmented seed coats and open head types are more tolerant.

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**Table 2. Characteristics symptoms of grain sorghum foliar diseases**

<table>
<thead>
<tr>
<th>Disease</th>
<th>Pathogen</th>
<th>Lesion Shape</th>
<th>Lesion Size</th>
<th>Lesion Color</th>
<th>Other Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf Blight</td>
<td>Exserohilum turcicum</td>
<td>Irregular, cigar-shaped</td>
<td>≥ 1&quot;</td>
<td>Gray with tan-red borders</td>
<td>Very large elongated spots</td>
</tr>
<tr>
<td>Root Rot</td>
<td>Bipolaris sorghola</td>
<td>Round, elliptical</td>
<td>½ to 1&quot;</td>
<td>Tan with red borders</td>
<td></td>
</tr>
<tr>
<td>Gray leaf spot</td>
<td>Cercospora sorghi</td>
<td>Elongate to rounded</td>
<td>≥ 1&quot;</td>
<td>Dark purple</td>
<td>Lesions may become sunken</td>
</tr>
<tr>
<td>Zonate leaf spot</td>
<td>Gloeosperospora sorghi</td>
<td>Irregular to semi-circular</td>
<td>Lesions can combine to form large spots</td>
<td>Alternating dark purple and tan</td>
<td></td>
</tr>
<tr>
<td>Rough spot</td>
<td>Ascochyta sorghi</td>
<td>Broad, elliptical</td>
<td>½ to 1&quot;</td>
<td>Grayish to yellow or purple</td>
<td>Lesions resemble bulb’s-eye target; similar to seedling blights produced by maize dwarf mosaic virus; lesions may develop on the upper leaves of sorghum, and cover the entire leaf; center of lesion rough to touch; leaves look like fine handprints</td>
</tr>
<tr>
<td>Sooty stripe</td>
<td>Ramulispora sorghi</td>
<td>Elongate, elliptical</td>
<td>3 to 5 ft long, ½&quot; wide</td>
<td>Tan center; purple margins</td>
<td>Center of old lesions appear sooty</td>
</tr>
<tr>
<td>Rust</td>
<td>Puccinia purpurea</td>
<td>Round to elliptical, raised pustules or blisters</td>
<td>≤ ½ to ¾&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southern leaf blight</td>
<td>Bipolaris maydis</td>
<td>Angular</td>
<td>Small flecks to 1½&quot;</td>
<td>Tan</td>
<td>Minor significance</td>
</tr>
<tr>
<td>Anthracnose</td>
<td>Colletotrichum gramineola</td>
<td>Elliptical</td>
<td>≤ ½ to ¾&quot;</td>
<td>Tan to red with distinct margins</td>
<td>Spore masses common in lesions; can develop on leaves and stems</td>
</tr>
<tr>
<td>Bacterial stripe</td>
<td>Bipolaris sorghi</td>
<td>Elliptical</td>
<td>≤ ½ to ¾&quot;</td>
<td>Red stripes</td>
<td>Confluent between leaf veins; appears in lower leaves first</td>
</tr>
<tr>
<td>Bacterial streak</td>
<td>Xanthomonas campestris pv. audaciosa</td>
<td>Rectangular</td>
<td>1 to 6 ft long, ½&quot; wide</td>
<td>Yellow stripes</td>
<td>Red-brown blotches appear in streaks, may broaden into oval spots with tan center and narrow, red margins</td>
</tr>
</tbody>
</table>

Harvesting

Grain sorghum does not reach moisture levels suitable for direct marketing (14.0%) or safe storage (13.5%) until after the application of a harvest aid or desiccant or a killing frost in Kentucky. Typically grain sorghum is harvested when seed moisture is between 18 and 22 percent after a harvest aid/desiccant application. In most fields, if harvest is delayed until after a killing frost significant pre-harvest loss can occur due to birds, insects, head molds, and unfavorable weather conditions. For full details on harvesting, drying, and storing grain sorghum refer to AEN-17: Harvesting, Drying, and Storing Grain Sorghum (http://www2.ca.uky.edu/agc/pubs/aen/aen17/AEN17.PDF).

Grain sorghum is typically harvested with a conventional sicklebar header. Stalks should be cut as high as possible to maximize grain heads harvested while minimizing the amount of plant tissue harvested. Grain sorghum stalks are usually much wetter than corn stalks, which allows them to be chopped and delivered to the grain tank, which can result in considerable foreign matter (in this case stalks) in the grain. If heads are drooping or stalks have lodged, pick-up type guards are recommended.

Summary

Diversifying grain crops production systems to include several crops can provide a means to mitigate losses due to uncontrollable environmental conditions. In Kentucky, grain sorghum is an excellent option because adapted hybrids with high yielding capabilities are available. Furthermore, grain sorghum tolerates droughty conditions and can produce high yields with fewer inputs than corn. The main considerations for grain sorghum production are weed, insect, and disease management. With good agronomic management grain sorghum can be a very profitable crop in Kentucky.

References and Resources


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