Balanced Nutrition and Crop Production Practices for Closing Grain Sorghum Yield Gaps

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Abstract
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Keywords
sorghum, production practices, nutrients, yield

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Summary
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Introduction
Kansas sorghum producers face the problem of low attainable yield. Grain sorghum is one of the major crops grown in the state of Kansas, and addressing this problem will improve short-term yield and crop productivity. Using better genotypes and best management practices are essential to closing grain sorghum yield gaps. This project is unique in that it takes into account the multitude of factors that influence farmers’ decisions in an effort to quantify the diverse interactions that can maximize yields.

Procedures
At the two locations, Ottawa, KS (dryland), and Rossville, KS (irrigated), the plots were set up with 5 replications with 11 treatments in each replication for the sorghum phase (Table 1). A randomized complete block design was used for the grain sorghum treatments, and side-by-side corn comparison plots were grown on each side of the sorghum replications (2 extra treatments, low vs. high production input for corn). The plots were
10 ft × 50 ft, or 0.01 acres. The hybrids used were Sorghum Partners NK7633 for sorghum and Pioneer 1151 for corn. Measurements for plant characterization were taken at the V5 growth stage, flowering, mid-reproductive stage, and at harvest. The measurements taken included: plant population stand counts, leaf area index (LAI) at V5 and flowering, chlorophyll (SPAD) readings at V5 and flowering, canopy temperature at flowering, aboveground biomass and nutrient concentrations at diverse growth stages, and grain yield and its components (grain number/head and seed weight).

Results
Grain sorghum yields were 60 to 80 bu/a in Ottawa (dryland), with lower yield potential related to the limited precipitation experienced during the reproductive period (Figure 1). At Rossville, grain sorghum yields were 115 to 135 bu/a, with higher yield potential related to the irrigation scheduling system (irrigated site) (Figure 2). At Ottawa, the cropping system approach did not influence sorghum grain yields, which may be related to the low yield potential explored in this location (reproductive-stage drought stress). At Rossville, the maximum yield gap documented between the highest-yielding treatment (“kitchen sink,” or all inputs are applied but without chloride, treatment 9) and the lowest-yielding scenario (check, treatment 10) was close to 20 bu/a (135 vs. 114 bu/a, respectively). The diverse systems evaluated did not differ in sorghum grain yield, with a statistically significant yield difference from all treatments versus the check, a common-practice approach (treatment 10).
Table 1. Description of sorghum treatments implemented in this study

<table>
<thead>
<tr>
<th>Treatments</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
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<tbody>
<tr>
<td>Seeding rate</td>
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<td>Normal</td>
<td>Optimum</td>
<td>Optimum</td>
<td>Optimum</td>
<td>Optimum</td>
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<td>Row spacing</td>
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<td>15 in.</td>
<td>30 in.</td>
<td>15 in.</td>
<td>15 in.</td>
<td>15 in.</td>
<td>15 in.</td>
<td>15 in.</td>
<td>15 in.</td>
<td>30 in.</td>
<td>15 in.</td>
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<tr>
<td>N program</td>
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<td>GS</td>
<td>GS</td>
<td>Standard</td>
<td>GS</td>
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<td>GS</td>
<td>GS</td>
<td>GS</td>
<td>Standard</td>
<td>GS</td>
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<tr>
<td>Fungicide/insecticide</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>None</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Chloride</td>
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<td>No</td>
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</tr>
</tbody>
</table>

Optimum seeding rate = 80,000 plants/a; Normal = 50,000 plants/a; 15 in. = narrow row spacing; 30 in. = wide row spacing; GS = GreenSeeker meter (Trimble Navigation, Westminster, CO); Standard = conventional N application (without precision ag technology); Fe = Iron; Zn = Zinc; PGR = plant growth regulator; N = nitrogen; P = phosphorus; K = potassium; S = sulfur.
Figure 1. Sorghum grain yield under diverse cropping systems approaches at the Ottawa Unit of the East Central Kansas Experiment Field. See Table 1 for treatment details.

Figure 2. Sorghum grain yield under diverse cropping systems approaches at the Rossville Unit of the Kansas River Valley Experiment Field. See Table 1 for treatment details.