Outline

• Yield formation
• Hybrid selection
  – Maturity vs. growing season
  – Seed and plant color
  – Resources/tools
• Planting
  – Populations
  – Row spacing
• Tillage and rotation
Sorghum Yield Formation
Vegetative

<table>
<thead>
<tr>
<th>Growth stage</th>
<th>Days after emergence</th>
<th>Identifying characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td><strong>Emergence</strong> – coleoptile visible at soil surface</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td><strong>3 leaf collars</strong> – growth rate depends on temperature</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td><strong>5 leaf collars</strong> – rapid root development, growing point below soil surface</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td><strong>Growing point differentiation</strong> – ~ 8 leaf collars (7 to 10), rapid growth, nutrient uptake, and stem elongation</td>
</tr>
</tbody>
</table>
2,4-D at V5 to V6
Reproductive

<table>
<thead>
<tr>
<th>Growth stage</th>
<th>Days after emergence*</th>
<th>Identifying characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>30</td>
<td><strong>Growing point differentiation</strong> – ~ 8 leaf collars (7 to 10), rapid growth, nutrient uptake, and stem elongation</td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td><strong>Flag leaf visible</strong> – final leaf visible in whorl, head developing</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td><strong>Boot</strong> – head extended into flag leaf sheath, all leaves expanded, max. light interception, head size determined</td>
</tr>
<tr>
<td>6</td>
<td>60</td>
<td><strong>Half bloom</strong> – half of plants at some stage of bloom, half of DM accumulated</td>
</tr>
</tbody>
</table>
Sorghum Ergot
## Grain Fill and Maturity

<table>
<thead>
<tr>
<th>Growth stage</th>
<th>Days after emergence*</th>
<th>Identifying characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>70</td>
<td><strong>Soft dough</strong> – rapid grain fill, from leaves and stalk</td>
</tr>
<tr>
<td>8</td>
<td>80</td>
<td><strong>Hard dough</strong> – nutrient uptake complete, but DM at 75%</td>
</tr>
<tr>
<td>9</td>
<td>90</td>
<td><strong>Physiological maturity</strong> – max. DM accumulation, formation of black layer</td>
</tr>
</tbody>
</table>
Sorghum Yield Formation

- Need warm temperatures and minimal weed competition for good early growth.
  - Root system, early (productive) tillers
  - Starter fertilizers especially helpful with early and/or no-till planting
- Head forms during 30 days before bloom.
  - Head size is determined before bloom
  - Be careful with herbicide applications
- Pollination can be affected by cool temperatures, or hot, dry winds
  - Seed set is determined during bloom (or maybe just before bloom)
  - Ergot, sorghum midge can reduce seed set
- Grain fill is very rapid soon after bloom.
  - Seed size is determined during grain fill
  - Grain fill saps stalk making it susceptible to rots
  - Need adequate fertility for max yield
  - Need healthy leaves for max yield (sooty stripe, greenbug, etc.)
Hybrid Maturity and Year

Barney Gordon, K-State Research & Extension, Belleville
Hybrid Maturity and Planting Date
Scandia 1994-1996

Barney Gordon, K-State Research & Extension, Scandia
Hybrid Maturity and Planting Date
St. John 1993-1995

Yield, bu/acre

- Early
- Medium
- Late

Late April | Mid-May | Late May | Mid-June | Early July*

*1994-1995
Probability of Sorghum Maturing Before a Freeze

August 4 Bloom

August 9 Bloom
Plant and Seed Color Effect on Laboratory Germination and Vigor

Pedersen and Toy, 2001
Plant and Seed Color Effect on Field Performance

![Chart showing emergence, days to bloom, yield, and test weight for white seed, red seed, tan plant, and purple plant, with data from Pedersen and Toy, 2001.](image-url)
Hybrid Selection Summary

- Fit hybrid maturity to available growing season and soil moisture
- Seed and plant color may influence germination and emergence, but hybrid and seed lot are more important
- Select high-yielding hybrids that resist stalk rots and stand well
- Use multiple sources of information to document hybrid performance over several locations and years
Hybrid and Plant Population Effects on Irrigated Grain Sorghum Yield

Barney Gordon, K-State Research & Extension, Belleville
Hybrid Maturity and Population
2005 and 2006

Barney Gordon, K-State Research & Extension, Belleville

Barney Gordon, K-State Research & Extension, Scandia
Plant Population Effect on Sorghum Yield

![Graph showing the effect of plant population on sorghum yield. The graph plots yield (bu/acre) against population (plants/acre) with different lines representing different hybrids.]

- **Yield, bu/acre**: 160, 140, 120, 100, 80
- **Population (plants/acre)**: 0, 20, 40, 60, 80, 100, 120, 140, 160

- **Lines and Colors**:
  - Red: MO 05
  - Yellow: HUT 08*
  - Purple: MAN 08-10*
  - Blue: MAN 08-20*
  - Blue: MAN 08-30*

- *Average of ME and ML hybrids
Plant Population Effect on Sorghum Yield, Belleville 1996

Staggenborg, Fjell, Devlin, Gordon, Marsh
Population Summary/Conclusions

- ~ 40,000 plants/acre sufficient for Hutchinson
- 50,000 to 60,000 plants/acre sufficient for Manhattan, Missouri and Scandia dryland or limited irrigation
- 75,000 to 80,000 plants/acre sufficient for ≥2 irrigations and med-full season hybrids
- May need >80,000 plants/acre with irrigated early-medium maturity hybrids
- Fuller maturity hybrids maximized yield at lower populations than early-med hybrids (if full growing season was available)
- Narrow rows (<30”) were more responsive to population
Row Spacing Effect on Sorghum Yield – 16 Studies

- Grain Yield, bu/acre
- Row Space (inches)

Legend:
- Bell 95
- Bell 96
- Bell 97
- Bell 98
- MO 02
- MO 03
- HUT 08
- MAN 08
- WEL 97
- MAN 97
- ISA 98M
- ISA 98J
- MAN 95
- POW 95
- BEL 95
- MAN 96
- BEL 96
Row Spacing Effect
Kansas Summary

Grain Yield, bu/acre vs. Row Space (inches)

- Narrow Better (C, NE 7*)
- Wide Better (NC 2)
- No Effect (NC, NE 3)
- No Effect (SC 4)

*Number of Experiments
<table>
<thead>
<tr>
<th>Row Space (inches)</th>
<th>Late May</th>
<th>Late June</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>135</td>
<td>115</td>
</tr>
<tr>
<td>15</td>
<td>132</td>
<td>125</td>
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</tbody>
</table>

Barney Gordon, K-State Research & Extension, Scandia
Skip-Row Planting
P2S2, 2007 Tribune, KS; Alan Schlegel and Lucas Haag

![Bar graph showing bushels per acre for corn and sorghum under conventional (Conv.) and skip (Skip) planting methods.](image)
Skip-Row Planting
P2S2, 2008 Tribune, KS; Alan Schlegel and Lucas Haag

Bushels per acre

- Corn
- Sorghum

Conv. Skip

0 20 40 60 80 100 120 140
Clump Grain Sorghum Planting
Tribune, KS; Alan Schlegel and Lucas Haag

WSF Rotation

Bushels per acre

<table>
<thead>
<tr>
<th>Year</th>
<th>Conv.</th>
<th>Clump</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td></td>
<td></td>
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<tr>
<td>2007</td>
<td></td>
<td></td>
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<tr>
<td>2008</td>
<td></td>
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</tbody>
</table>
Planting Geometry Affects Tillering

Tribune, KS; Alan Schlegel and Lucas Haag

Heads per plant

Conv.  P2S2  Clump

All at 33,000 seeds/acre
Row Spacing
Summary/Conclusions

• Narrower rows may provide the opportunity to capture greater yields at higher populations in favorable environments (>heads/plant, larger heads)
• Narrow rows may be a detriment in dry environments
• Narrow rows may be more advantageous at later planting dates
• Hybrid maturity usually had no effect on row spacing response
• Select hybrids with resistance to stalk rots and excellent standability for narrow rows
• Skip row or clump planting may have merit in dry environments
Rotation and Tillage
Rotation and N Effect on Sorghum Yield (7 years)

Barney Gordon, K-State Research & Extension, Belleville
Rotation and N Effect on Sorghum Yield (20 years)

Grain Yield, bu/acre

Nitrogen (pounds/acre)

GS-GS

SB-GS

Varvel and Wilhelm, Mead, NE
Preceding Crop Effect on Sorghum Yield

Bushels per acre

Previous Crop

Wheat
[Soybean]
Soybean
[Sorghum]
Sorghum

Mark Claassen, Hesston, 4 years
Rotation and tillage effects on 10-year average winter wheat yield.
Grain Sorghum and Wheat Response to Rotation – 11 Years, Tribune, KS

Yield, bu/acre

wSsf | wsSf | Wssf | wwSf | Wwsf | wWsf | WW

Alan Schlegel, Tribune
Net Returns for Grain Sorghum, Wheat Rotations – 11 Years, Tribune, KS

Short-run prices
Long-run prices

Alan Schlegel, Tribune; Troy Dumler, Garden City
Grain Sorghum Response to Tillage 31 Years, Manhattan, KS

Yield, bu/acre

<table>
<thead>
<tr>
<th></th>
<th>GS-SB</th>
<th>GS-GS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>95</td>
<td>85</td>
</tr>
<tr>
<td>Reduced</td>
<td>90</td>
<td>87</td>
</tr>
<tr>
<td>NT</td>
<td>80</td>
<td>83</td>
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Dallas Peterson, Manhattan
Grain Sorghum Response to Tillage W-S-F, Tribune, KS

Alan Schlegel, Tribune
Grain Sorghum Response to Tillage W-S-F, Tribune, KS

Alan Schlegel, Tribune

- Wheat Sorghum Rotation

Yield, bu/acre

Alan Schlegel, Tribune; Troy Dumler, Garden City
Dryland Sorghum Yield Increases Over Time, Bushland, TX

- Yields increased 0.8 bu/a/year over 50 years
- Improved hybrids accounted for about 33% of yield increase
- Soil water content at planting was single largest other factor contributing to yield increases – related to reductions in tillage and increased surface residue

Rotation and Tillage Summary

• Sorghum almost always yields more when in rotation, regardless of N rate.
• Increasing the number of years between sorghum crops can enhance “rotation effect”.
• Rotation is critical for no-till success.
• No-till response can improve over time.
• No-till can save enough soil moisture to make a BIG yield difference.
Questions?