Grain Sorghum Planting Management

Ignacio A. Ciampitti
Doo-Hong Min
Lucas Haag
Stu Duncan
John Holman
Kraig Roozeboom
Alan Schlegel
Outline:

- Yield trend for W. KS (Dryland vs. Irrigated)

- **Review**: Sorghum vs. Corn

- Planting Management
  - Row Spacing
  - Plant Population
  - Planting Date
  - Hybrid Selection
  - Rotation effect
  - Water use
Dryland Sorghum Yields (Long-term)

- Trend is more “flat”
- Max. yield 150 bu./A

Grain Yield (bu/A)

Year


0 30 60 90 120 150 180 210

- Colby
- Hays
- Tribune
- Garden City

KANSAS STATE UNIVERSITY
College of Agriculture
Department of Agronomy
Crop, Soil, and Range Sciences
5-yrs Yield “Dryland” Grain Sorghum
(Western Kansas, K-State Crop Performance Test)

5-yrs Grain Yield Trend
- Yields below 150 bu./A.
- Yields variable with yr
  (ranging from 30-150 bu./A)
Irrigated Sorghum Yields (Long-term)

- Overall: 0.5 bu/A/yr increase
- Colby + yield trend last 10-yrs
5-yrs Yield “Irrigated” Grain Sorghum (Western Kansas, K-State Crop Performance Test)

- More stable yields as compared with the “dryland” yield trend.
Outline:

- **Yield trends** (Dryland vs. Irrigated)

- **Review**: Sorghum vs. Corn

- **Planting Management**
  - Row Spacing
  - Plant Population
  - Planting Date
  - Hybrid Selection
  - Rotation effect
  - Water use
Dryland Sorghum Yields (Long-term)

Y = 0.83X

- Trend is lineal
- Max. yield 150 bu./A
Irrigated Sorghum Yields
(K-State Crop Performance Test)

- More stable yields as compared with the “dryland” yield trend.
**Planting Date (50%) Evolution: Sorghum in Kansas**

(Sorghum – Days after March 31st)

In the last 30 yrs, planting date was reduced 8 days (from June 14th 1981 to May 27th 2012)

Sorghum: -0.26 day per yr
Historical Yield Evolutions

Assefa et al. 2014

Outline
Yield Trends
Sorghum vs. Corn
Management Effects
Future ideas

Years
1840 1860 1880 1900 1920 1940 1960 1980 2000 2020

Average yield (bushel acre$^{-1}$)

- Corn
- Sorghum
- Soybean
- Wheat

Corn
Sorghum
Soybean

Assefa et al. 2014
Sorghum vs. Corn Yield & Harvested Area

Sorghum yielded 75% when yields < 80 bu./A

Sorghum harvested area increased in the last years

Grassini et al. 2014
Dryland : Historical Analysis 1970-2011 (40 yrs)

Assefa et al. 2014

KANSAS STATE UNIVERSITY

College of Agriculture
Department of Agronomy
Crop, Soil, and Range Sciences

Outline Yield Trends Sorghum vs. Corn Management Effects Future ideas

- Corn 72a
- Sorghum 64a
- Soybean 25c
- Wheat 40b

- Corn 71a
- Sorghum 63a
- Soybean 24c
- Wheat 39b

- Corn 69a
- Sorghum 62a
- Soybean 23c
- Wheat 38b

- Corn 57a
- Sorghum 53a
- Soybean 21c
- Wheat 37b

- Corn 54a
- Sorghum 51a
- Soybean 19c
- Wheat 34b

- Corn 45a
- Sorghum 41a
- Soybean 19c
- Wheat 31b

- Corn 56a
- Sorghum 51a
- Soybean 22c
- Wheat 34b

- Corn 75a
- Sorghum 62b
- Soybean 21d
- Wheat 33c

- Corn 59
- Sorghum 54

Central & SC

Soybean 22d
Wheat 34c

Dryland

Assefa et al. 2014
Irrigated: Historical Analysis 1970-2011 (40 yrs)

Assefa et al. 2014

Central & SC
Corn 146
Sorghum 92

Future ideas

Management Effects

Outline

Yield Trends

Sorghum vs. Corn

Corn 159a
Sorghum 94b
Soybean 43c
Wheat 48c

Corn 159a
Sorghum 94b
Soybean 43c
Wheat 48c

Corn 150a
Sorghum 89b
Soybean 42c
Wheat 49c

Corn 150a
Sorghum 94b
Soybean 43c
Wheat 48c

Corn 139a
Sorghum 97b
Soybean 43c
Wheat 51c

Corn 142a
Sorghum 92b
Soybean -
Wheat 45c

Corn 142a
Sorghum 92b
Soybean -
Wheat 45c

Corn 146
Sorghum 92

Corn 113a
Sorghum 88b
Soybean 34c
Wheat -
Management Practices:

- Row Spacing
- Plant Population
- Planting Date
- Hybrid Selection
- Rotation effect
- Water use
Management Practices: Sorghum

Identifying Critical Plant Components

YIELD COMPONENTS VARIATION

(Max. – Min. / Min) x 100 = %Variation

1100% Plants/Acre
3500% Seed#/Plant

433% Tillers/Plant
220% Gm/seeds
Management Practices: Sorghum
Identifying Critical Plant Components

Grain number is the main YIELD component highly associated with the final sorghum YIELD.

Grain weight is slightly influencing ("flat trend") the final sorghum YIELD.
Grain Sorghum Yield Response to Plant Population (or Density)

Sorghum Yields:
In the last 30 yrs, the association between yields and plant density is not consistent.
Grain Sorghum Yield Response to Plant Population (or Density)

Yield response to plant density was "flat" at all Western KS sites.

Optimum 20-30K for Max. YIELDS.

Tribune, Garden City, Colby 2009-10
Seeding Rate/Stand Summary

• Central and Eastern KS (>25 inches precipitation)
  – Final stands of 50,000 to 70,000 can maximize yield
    • Aim for plant populations that result in 1 to 1.5 heads/plant
    • Adjust seeding rates up with later planting
      (~20-25% greater if planting in mid-June or later)

• Western KS
  – Final stands of 20,000 to 30,000 plants per acre can maximize yield
    • Can support yields of 60 to 80 bushels per acre or more
    • Heads per plant and seeds per head adjust to growing conditions
Grain Sorghum Yield Response to Row Spacing

Yield Wide Rows - 30" (bu/A)
Yield Narrow Rows - 10" (bu/A)

Outline
- Yield Trends
- Sorghum vs. Corn
- Management Effects
- Future ideas

Grain Sorghum Yield Trends

Sorghum vs. Corn Management Effects

Future ideas

Grain Sorghum Yield Response
to Row Spacing

Yield Narrow > Wide

66% from the “+cases” for Narrow Row Yield values > 70 bu/A.

Yield Narrow < Wide

Overall
+4 bu./Acre

Yield
Narrow
Wide

Yield
Narrow > Wide

Yield
Narrow < Wide

Yield Wide Rows - 30" (bu/A)
Narrow rows can produce greater yields at typical or greater populations in high-yield environment.

Under low yielding environments, the response to narrow rows under diverse population levels is similar to wide rows.

Tribune & Hutchinson, 1985
Grain Sorghum: Planting Date

This summary showed “Early June as the optimum planting date for Max. Yields.

Grain Yield (bu/A)

**OPTIMUM PLANTING DATE**

<table>
<thead>
<tr>
<th>April</th>
<th>May</th>
<th>June</th>
<th>Early July</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late</td>
<td>E</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>E</td>
<td>M</td>
<td>L</td>
<td>E</td>
</tr>
<tr>
<td>M</td>
<td>L</td>
<td>E</td>
<td>M</td>
</tr>
<tr>
<td>L</td>
<td>E</td>
<td>M</td>
<td>L</td>
</tr>
</tbody>
</table>

E = Early
M = Mid
L = Late

Planting Date Revision:

Tribune/ Hutchinson/ Manhattan (Vanderlip) Scandia 1994-1996 (Gordon)
St. John 1993-1995 (Martin & Vanderlip)
Columbus 2000/03 (Kelley)
Grain Sorghum: Hybrid Selection Maturity

This summary showed the complexity of the hybrid selection. “Full (early) to medium maturity hybrids showed high yields.

Planting Date Revision:

Tribune/ Hutchinson/ Manhattan (Vanderlip)
Scandia 1994-1996
(Gordon)
St. John 1993-1995
(Martin & Vanderlip)
Grain Sorghum: Hybrid x Planting Date

Low yielding environment (<75 bu./A), yields were similar regardless of the planting date.

Yields (>100 bu./A) for medium and late maturity hybrids, “early” June maximize YIELDS.
Grain Sorghum: Hybrid x Planting Date

- Plant as early as soil temperatures allow
  - Once soil temperatures reach 65° to 70° F
  - Can benefit from delayed planting into mid-June depending on year (heads and fills grain after worst of heat, catches late-summer rains)
- Plant the fullest maturity hybrid adapted to your area
  - Earlier maturing hybrids when planting is delayed into mid-June or later in W, NC KS and SC NE, late June in SC KS, July in eastern KS
    - Usually want sorghum to head
      - By early August in NW KS
      - By mid-August in SW, SC, NC, NE
      - By late August in central KS
      - By early September in SC, SE KS
- Think about next crop
  - e.g. If planting wheat immediately after sorghum...
    - Use an earlier hybrid
    - Plant earlier
Planting Geometry (Row Spacing) and Seeding Rate – Driving Factors

• What drives plant growth?
  – Sunlight

• What does the plant need to convert sunlight to biomass
  – Water

• Assuming we are doing a good job of managing other factors (fertility, pests) within the growing season we are limited by one of two things light or water.
Grain Yield (% of Max) vs. Increasing Plant Population or Reduced Row Spacing

- Light Limiting Region
- Optimal Region
- Water Limiting Region

Outline
Yield Trends
Sorghum vs. Corn
Management Effects
Future ideas
Crop Water Use

• Often thought of in a single plant frame of reference.
  – “If one plant uses 1000 g of water per day, two plants must use 2000 g of water per day.”
LAI and Light Interception

Outline
Yield Trends
Sorghum vs. Corn
Management Effects
Future ideas
Light and Row Spacings

30 in 15 in
Light Interception

![Graph showing light interception percentages over time for different crop row spacings (20 in, 40 in, 60 in). The graph plots the evolution of light interception from July 2 to August 31.](image-url)
Planing Geometry (Row Spacing) and Seeding Rate – Driving Factors

Water use is driven by **Light interception**

Row spacing and plant population

Which can be effected by

Increased light interception is good if you have the water to support it
Sorghum – Planting Geometry

Conventional

Clump

Skip

Roozeboom et al.
Haag et al.
Sorghum – Planting Geometry

Conventional vs. Skip

= Yields
(potential yield gain in low yield sites)

Conventional vs. Clumping

= Yields
(potential yield gain in low yield sites)
Row Spacing and Clump Planting Summary

• **Skip Row**
  - Early research showed possible yield increase in low yield environments
  - Subsequent research found no difference or slight yield decrease
    - Weed management
  - Not advisable, particularly for high yield environments

• **Clump planting**
  - Early research showed potential to stabilize or increase yields in low yield environments
  - Subsequent research showed no consistent advantage to conventional
  - Reduces tillering, may need to increase seeding rate to not loose top end potential
  - Possible disadvantage to planting early maturity hybrids by clump
Planting Geometry (Row Spacing) and Seeding Rate – Driving Factors

Many other reasons that to alter seeding rate or row spacing

- Reduced evaporation losses
- Better distribution of surface residue
- Weed control

- Consider machinery management issues
  - Handling residue during seeding
  - Seed metering
  - Fertility placement
Grain Sorghum: Water Supply

Grain Sorghum yield is correlated to the total amount of water supply in dryland & limited irrigation

- Available soil water at planting
- In-Season Precipitation
- Irrigation
Grain Sorghum: Water Supply

Grain Sorghum yield is correlated to the total amount of water supply in dryland & limited irrigation.

\[ Y = 2.7 \times X \]

Yield vs. Water Supply (inch)

- Colby
- Hays
- Tribune
- Garden City

Historical Trend (1955-2011)

One inch of water produced in overall close to 3 bu./A.
Grain Sorghum Yield associated with Water Supply Components
SWREC-Tribune 1973-2003

Increasing available soil water at planting

Available Soil Water at Planting

- 0
- 2
- 4
- 6
- 8
- 10
- 12
Management effects available soil water at planting and probability of attaining yield goal

Grain Sorghum Yield Goal (bu ac\(^{-1}\))

% of Seasons with Adequate ISP to Achieve Yield Goal

10 cm (4 in.) Cut Stubble
25 cm (10 in.) Cut Stubble
71 cm (28 in.) Stripped Stubble

15 June - 14 Sept. Precipitation at McCook, NE 1909 - 2006

Assumption of 50% profile ASW prior to snow catch
## Irrigation Timing and Grain Sorghum

Tribune, KS

<table>
<thead>
<tr>
<th>Time of Irrigation</th>
<th>Yield (bu/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preplant only</td>
<td>65</td>
</tr>
<tr>
<td>Pre+Boot Stage</td>
<td>125</td>
</tr>
<tr>
<td>Pre+Half-Bloom</td>
<td>115</td>
</tr>
<tr>
<td>Pre+Soft-Dough</td>
<td>114</td>
</tr>
<tr>
<td>Full Season Irrigation</td>
<td>126</td>
</tr>
</tbody>
</table>
Grain Sorghum: Effect of Limited Irrigation

General Procedures

• No-till for all crops
• Sprinkler irrigation at most critical time (maximum of 1.5 in/wk)
• Soil water and crop measurements
• Machine harvest
• Precipitation Summary

Tribune; Schlegel et al.
Limited Irrigation, Tribune

Summer Rainfall

Year

Precipitation, inch

June
July
Aug.

2004
2005
2006
2007
2008
Normal

2004
2005
2006
2007
2008

Limited Irrigation, Tribune

SWREC-Tribune, Schlegel et al.
Grain Sorghum Yield with Limited Irrigation

2004-08 Limited Irrigation, Tribune

SWREC-Tribune, Schlegel et al.
Grain Sorghum: Rotation Effect
Winter Wheat after Sorghum

Improving the Performance of Winter Wheat Planted without Tillage After Grain Sorghum

Jennings & Roozeboom
Management

• Three Treatments:
  - Glyphosate (Sorghum):
    - Pre-harvest, Post-harvest, No Treatment
  - Residue:
    - Residue Chopped, Residue Removed, No Treatment
  - Nitrogen:
    - 30 lb/UAN Applied to Sorghum Residue, No Treatment
Pre-harvest glyphosate had no significant impact on yields.

Jennings & Roozeboom
Wheat Yields

2012 - Wheat

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (bu ac⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Glyphosate</td>
<td>47*</td>
</tr>
<tr>
<td>Post-Glyphosate</td>
<td>42</td>
</tr>
<tr>
<td>No Treatment</td>
<td>42</td>
</tr>
<tr>
<td>Residue Chopped</td>
<td>43</td>
</tr>
<tr>
<td>Residue Removed</td>
<td>42</td>
</tr>
<tr>
<td>No Treatment</td>
<td>46*</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>44</td>
</tr>
<tr>
<td>No Treatment</td>
<td>42</td>
</tr>
</tbody>
</table>

Jennings & Roozeboom
Pre-harvest glyphosate had no significant impact on yields.

Jennings & Roozeboom
Wheat Yields

2013 - Wheat

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (bu ac⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Glyphosate</td>
<td>41</td>
</tr>
<tr>
<td>Post-Glyphosate</td>
<td>41</td>
</tr>
<tr>
<td>No Treatment</td>
<td>40</td>
</tr>
<tr>
<td>Residue Chopped</td>
<td>40</td>
</tr>
<tr>
<td>Residue Removed</td>
<td>38</td>
</tr>
<tr>
<td>No Treatment</td>
<td>44*</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>40</td>
</tr>
<tr>
<td>No Treatment</td>
<td>41</td>
</tr>
</tbody>
</table>

Jennings & Roozeboom
Pre-harvest glyphosate on the left, and post-harvest glyphosate on the right.
Summary: Rotation Effect

• Pre-harvest glyphosate had no significant impact on grain sorghum yields.
• Sorghum harvest moisture was drier with pre-harvest glyphosate, but differences would not effect management decisions.
• Post-harvest glyphosate and Nitrogen applications to sorghum residue had no impact on wheat yields.
• When yields were greater when sorghum residue was left standing.
• Harvest and residue management of sorghum can influence yields of winter wheat in no-till systems.