Grain Sorghum 
Production Management

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Northwest Research-Extension Center, Colby

Outline:
- Yield trends
- Sorghum Characteristics
- Planting Management
  - Row Spacing
  - Plant Population
  - Planting Date
  - Hybrid Selection
  - Tillage and Rotation Effects
  - Water use
Dryland Sorghum Yields (Long-term)

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

Irrigated Sorghum Yields (Long-term)

- Overall: 0.5 bu/A/yr increase
- Colby yield trend last 10 yrs

1.1 bu/A/yr
**Planting Date (50%) Evolution: Sorghum in Kansas**

(Sorghum – Days after March 31st)

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

**Management Practices:**
Understanding Sorghum Yield 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.
Sorghum and Drought

• Drought Tolerance
  – The ability to maintain growth during periods of water stress.

• Drought Avoidance
  – The ability to alter plant development or physiological processes to survive a period of water stress.

Sorghum Drought Tolerance

• 50% more stomata per in\(^2\) of leaf than corn
• Stomata are smaller
• Extensive root system
• Small leaf:root ratio compared to other crops
• Perfect flowers
• Stay-Green Traits
Drought Avoidance

• Heavy wax layer (bloom) on leaves

• Slow/hasten maturity under stress

• Motor cells at leaf midrib to facilitate leaf curling under stress

Goal of Sorghum Production

• The primary goal of sorghum production is to minimize the damage.
  
  – Maximizing growing season water supply
  – Managing planting dates and maturities to minimize expected stress
  – Select hybrids that tolerate stressful conditions
Stay-Green and Sorghum

• Delayed senescence trait
  – Results in higher SLN
  – Higher Transpiration Efficiency
  – More C & N into roots during grainfill
  – Improves yields and reduces stalk lodging in the presence of stress during grain fill.

Mahalakshimi & Bidinger Crop Sci. 42:965-974

Susceptible Stages to Drought / Heat Stress: Cereals

Western Kansas

Pre-Flowering
Growth, Biomass and Panicle Emergence

At Flowering
Seed-set and Seed numbers

Eastern Kansas

Post-Flowering
Seed size, yield and Composition

Reproductive stages of flowering and seed-set are most sensitive to drought and heat stress. V. Prasad
Management Practices:
- Row Spacing
- Plant Population
- Planting Date
- Hybrid Selection
- Rotation effect
- Water use

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.
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

Water use is driven by **Light interception**

Which can be effected by **Row spacing and plant population**

Increased light interception is good if you have the water to support it
Narrow rows can produce greater yields at typical or greater populations in high-yield environment.

Tribune & Hutchinson, 1985

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

Planted vs. Drilled
A.J. Foster, Southwest Area Agronomist, SWREC-Garden City
Alan Schlegel, Agronomist-in-Charge, SWREC-Tribune
Study Setup

**Study 1: Dryland**
- **Locations**: Garden City & Tribune
- **Treatments**:
  - GC: Seeding rate: drilled @ 27,000, 40,500, 54,000, 67,500, and planted @ 27,000 seeds/A; Nitrogen rate: 50, 75, 100 lbs. N/A; planting method: Drilled and Planted
  - Tribune: Seeding rate: drilled @ 20,000, 40,000, 60,000, 80,000, and planted @ 40,000 seeds/A; Nitrogen rate: 0, 50, 100 lbs. N/A; planting method: Drilled and Planted.
- **Planting date**: GC – 2 June; Tribune - 7 June
- **Variety**: DK 3707
- **Herbicide Program**: Pre-plant—Roundup, harness and Starane

**Study 2: Irrigated (weed vs weed free)**
- **Location**: Garden City
- **Treatments**:
  - Seeding rate: 60000, 90000, 120000 lbs./A; Nitrogen Rate: 0, 100, 200 lbs./A; Weed Mgt.: half plots were managed weed free and half pigweed was allowed to grow.
- **Planting date**: 20 June 2016
- **Variety**: DK 3707
- **Herbicide Program**: Dicamba salt DMA (8oz) + Atrazine (1pt/ac)

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**Planted vs. Drilled**

<table>
<thead>
<tr>
<th>Planted</th>
<th>Drilled</th>
</tr>
</thead>
</table>

2017 Western Sorghum Schools - L. Haag
Planted vs. Drilled

<table>
<thead>
<tr>
<th>Garden City</th>
<th>Tribune</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeding Rate (seeds/A)</td>
<td>Seeding rate (Seeds/A)</td>
</tr>
<tr>
<td>27000</td>
<td>20000</td>
</tr>
<tr>
<td>40500</td>
<td>40000</td>
</tr>
<tr>
<td>54000</td>
<td>60000</td>
</tr>
<tr>
<td>67500</td>
<td>80000</td>
</tr>
<tr>
<td>Stand (27)</td>
<td>Stand (40)</td>
</tr>
<tr>
<td>LSD=4</td>
<td>LSD=7</td>
</tr>
</tbody>
</table>

Yield (bu/A)

Weed vs Weed free

Kansas Fertilizer Research Fund

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Weed vs Weed free

First Year Results

- Increasing sorghum population did not increase grain yield
- Field observation suggest that planting sorghum in narrow rows (<30 in.) could suppress weeds growing below the canopy.
  - This observation will be further evaluated within the irrigated weed/weed free experimental setup.
Grain Sorghum: Planting Date

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

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

- 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
Hoxie Average May, June, July, August Precip. = 11.82”
Sharon Springs Average May, June, July, August Precip. = 11.20”
Garden City Average May, June, July, August Precip. = 11.41”

Grain Sorghum Water Use
Long-term Cropping Systems Research

Alan Schlegel
Lucas Haag
Southwest Research-Extension Center – Tribune, Kansas

Soil Water at Sorghum Planting
WSF, Tribune, 2001-2016

Profile water, inch

<table>
<thead>
<tr>
<th>Tillage</th>
<th>Profile water, inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT</td>
<td>4</td>
</tr>
<tr>
<td>RT</td>
<td>6</td>
</tr>
<tr>
<td>NT</td>
<td>6</td>
</tr>
</tbody>
</table>

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Sorghum Planting

Available water, inch

Depth, ft

CT
RT
NT

Tillage Intensity, Tribune, KS 2001-2016

Average Sorghum Yields
WSF, Tribune, 2001-2016

Grain Yield, bu/a

CT
RT
NT

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Profile available soil water at sorghum planting

- **wwSf**: 9 inches
- **wSsf**: 9 inches
- **wsSf**: 5 inches

Rotation:

- Dryland Rotation, Tribune, KS, 1996-2016
Sorghum Yield

Yield, bu/a

Rotation

Dryland Rotation, Tribune, KS, 1996-2016

Sorghum Yields, 1st vs 2nd year

1996-2016

y = 0.7125x - 5.6427

R² = 0.6102
OPREC Dryland Sorghum Tillage Study

<table>
<thead>
<tr>
<th>Tillage</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>Three-year</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-till</td>
<td>54.8</td>
<td>53.9</td>
<td>73.7</td>
<td>60.8</td>
</tr>
<tr>
<td>Strip till</td>
<td>44.2</td>
<td>46.4</td>
<td>51.2</td>
<td>44.6</td>
</tr>
<tr>
<td>Minimum till</td>
<td>28.0</td>
<td>38.3</td>
<td>35.6</td>
<td>36.7</td>
</tr>
<tr>
<td>Mean</td>
<td>42.3</td>
<td>46.2</td>
<td>53.5</td>
<td>47.4</td>
</tr>
<tr>
<td>CV %</td>
<td>6.4</td>
<td>13.6</td>
<td>19.0</td>
<td>20.1</td>
</tr>
<tr>
<td>L.S.D.</td>
<td>6.1</td>
<td>NS</td>
<td>24.2</td>
<td>9.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Timing</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>Two-year</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-till</td>
<td>62.5a</td>
<td>81.7a</td>
<td>80.1a</td>
<td>74.8a</td>
</tr>
<tr>
<td>September (fall)</td>
<td>47.6b</td>
<td>77.6a</td>
<td>54.1b</td>
<td>59.1b</td>
</tr>
<tr>
<td>March (spring)</td>
<td>45.5b</td>
<td>66.9a</td>
<td>56.6b</td>
<td>57.9b</td>
</tr>
<tr>
<td>January</td>
<td>42.1b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>37.9b</td>
<td></td>
<td></td>
<td></td>
</tr>
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Dryland Strip-Till
Do the perceived benefits outweigh the known residue cost?
Grain Sorghum Yield associated with Water Supply Components
SWREC-Tribune 1973-2003

In Season Precipitation (15 June - 14 Sept)

Grain Yield (bu ac⁻¹)

Available Soil Water at Planting

0 2 4 6 8 10 12 14 16

0.00 2.00 4.00 6.00 8.00 10.00 12.00 14.00 16.00

Adapted from Stone and Schlegel
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In-Furrow Humic Acid in Grain Sorghum – Year 1

Lucas Haag, Northwest Area Agronomist, NWREC-Colby
Jeanne Falk Jones, Sunflower Dist. Agronomist
Alan Schlegel, Agronomist-in-Charge, SWREC-Tribune

K-STATE Research and Extension
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Rationale

• We had received reports of in-furrow applications of humic acid reducing the occurrence of iron chlorosis

Materials and Methods

• Two Products Used
  – Raw Humic Acid (Soil Boost), 72% humic acid
  – Humic DG (The Andersons), 70% humic acid
• IDC Tolerant Hybrid, P87P06 used
• Planted in 30” rows, 45,000 seed drop
• 4 Replications per location
• 4 Locations
  – Colby, Wallace 1, Wallace2, Wallace 3
## In-Furrow Rates

<table>
<thead>
<tr>
<th>Product</th>
<th>30” Rate</th>
<th>Equivalent 10” Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Chipped Humic Acid</td>
<td></td>
<td>lbs/acre</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>90</td>
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<tr>
<td></td>
<td>40</td>
<td>120</td>
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<tr>
<td></td>
<td>70</td>
<td>210</td>
</tr>
<tr>
<td>Humic DG</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>105</td>
</tr>
</tbody>
</table>

## Locations - Wallace

![Locations - Wallace Image]
Locations - Colby

Results – Wallace 1

2016 Sorghum Humic Acid - Wallace 1

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Grain Sorghum Yield (bu/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>120</td>
</tr>
<tr>
<td>Raw @ 10 lb/ac</td>
<td>115</td>
</tr>
<tr>
<td>Raw @ 20 lb/ac</td>
<td>110</td>
</tr>
<tr>
<td>Raw @ 30 lb/ac</td>
<td>110</td>
</tr>
<tr>
<td>Raw @ 40 lb/ac</td>
<td>110</td>
</tr>
<tr>
<td>DG @ 7 lb/ac</td>
<td>110</td>
</tr>
<tr>
<td>DG @ 14 lb/ac</td>
<td>110</td>
</tr>
<tr>
<td>DG @ 21 lb/ac</td>
<td>110</td>
</tr>
<tr>
<td>DG @ 29 lb/ac</td>
<td>110</td>
</tr>
<tr>
<td>DG @ 35 lb/ac</td>
<td>110</td>
</tr>
</tbody>
</table>

n.s., p=0.5775
Results – Wallace 2

2016 Sorghum Humic Acid - Wallace 2
n.s. p=0.4709

Results – Wallace 3

2016 Sorghum Humic Acid - Wallace 3
n.s. p=0.7895
Results - Colby

2016 Sorghum Humic Acid - Colby

Summary

- In year one of the study, across four locations, we did not see a statistical or numerical response to in-furrow applications of humic acid in grain yield or IDC score.
- We are considering extending the study another year.
Questions?