Soybean Management

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2003 Kansas Ag Statistics

SOYBEANS

Legend 1 Dot = 15,000 bu.

695,000 acres 27%
17.9 M bushels 31%

1.7 M acres 66%
32.1 M bushels 56%
15-20”
20-25”
25-30”
30-35”
35-40”
40-45”

695,000 acres 27%
17.9 M bushels 31%

1.7 M acres 66%
32.1 M bushels 56%

2003 Kansas Ag Statistics
Soybean Management Practices

- Obtaining the highest yield potential on any crop is only as good as the most limiting factor.
- A producer has little to no control on the weather, but we can manage several things that do affect yield.
- What would it take to raise 100 bu/acre soybeans?
Tillage and Rotations
## Tillage Effects in A Long-Term Cropping Sequence/Rotation Study

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Corn/Soybean</td>
<td>Conventional</td>
<td>57</td>
<td>69</td>
<td>62</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>Reduced</td>
<td>56</td>
<td>70</td>
<td>64</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>No-till</td>
<td>56</td>
<td>68</td>
<td>63</td>
<td>62</td>
</tr>
<tr>
<td>LSD$_{0.05}$</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

Kansas River Valley Experiment Field, Topeka
# Soybean Tillage

- No tillage effects

<table>
<thead>
<tr>
<th>Tillage System</th>
<th>Average Soybean Yield 1984-2002 (even years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>22.0</td>
</tr>
<tr>
<td>Reduced</td>
<td>22.1</td>
</tr>
<tr>
<td>No-till</td>
<td>22.4</td>
</tr>
</tbody>
</table>

NS

Range of avg. yield during 1984-2002 was 5 to 42 bu/a with < 4 bu/a difference among tillage systems in any year

Sweeney and Kelley
Double Crop Soybean Tillage
10 yr Average (97-06)

Tillage LSD = 1.6
Rotation vs. Continuous Soybeans

- Longer soy is out of rotation the higher yield
  - Disease, insects, nutrient availability

Ken Kelley, 2005, Parsons
Crop Rotation - Hesston

- Soybean yields were similar after wheat, corn, or sorghum (~41.5 b/a).
- Adding an additional year of soybean in the rotation thru a double crop reduced yields 3.3 and 4.0 bu/a.

Claassen, 2009
Varieties

• I like a group 4.5-4.9 for south half of KS. For the north half of KS 4.5 to 3.5
• More than anything you need a consistent performing variety
  – Will be very farm specific
  – Often producer tests will help dictate which variety to plant
Planting Dates, Rates and Row Spacings
**Planting Date Evolution: Soybean in Kansas**

**Soybean Planting Dates:**
In the last 30 yrs, planting date was reduced 14 days (from June, 1\textsuperscript{st} 1980 to May 13\textsuperscript{th} 2012)

**Graph:**
- **Date at 50\% Planting Date**
- **Years**
- **Soybean: -0.48 day per yr**
Planting Date

• When water is not limiting, plant early:
  – Linear relationship between yield and water transp.
  – Produce the maximum number of nodes to hold pods (yield determination)
    • Delay planting: 0.24 and 0.63 bu/ac/day loss
  – Close crop canopy earlier in the season
    • Reducing evaporation
    • Cooler soil temperatures
    • Increase light interception

Specht; UNL
### Planting Date Summary in Kansas

- With good growing conditions, mid-May to early-June optimized yield

<table>
<thead>
<tr>
<th>Site, Year</th>
<th>Mid-Late May</th>
<th>Early-Mid June</th>
<th>Mid-Late June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powhatan, 2000-02</td>
<td>1.7</td>
<td>11.4</td>
<td>-9.0</td>
</tr>
<tr>
<td>Belleville, 1999, 2001</td>
<td>4.4</td>
<td>-26.2</td>
<td>-55.2</td>
</tr>
<tr>
<td>Topeka, 2000-02</td>
<td>-4.8</td>
<td>-15.1</td>
<td>-19.2</td>
</tr>
<tr>
<td>Ottawa, 1999-2002</td>
<td>6.6</td>
<td>-0.3</td>
<td>-25.8</td>
</tr>
<tr>
<td>Belleville, 2009-10</td>
<td></td>
<td>-6.5</td>
<td></td>
</tr>
<tr>
<td>Scandia, 2009-10</td>
<td></td>
<td>-4.5</td>
<td></td>
</tr>
<tr>
<td>Manhattan, 2010</td>
<td>-7.7</td>
<td>-15.3</td>
<td>-26.1</td>
</tr>
</tbody>
</table>

1 – No seed treatment in these studies
Planting Date

– High-yielding environments = early planting is good.
– Low-yielding environments = “flat” response...

In low-yielding environments (<40 bu/A), light is not the main limiting factor.
Water Stressed Soybean Planting Date

- Late May - June plantings sometimes highest yield
  - Maintain small plant through the heat and drought of the summer
    - Lower water demands to sustain growth
  - Rely on August and September precipitation to generate yield

Van Doren and Reicosky (1987)
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.
Light and Row Spacings

30 in  
15 in
Light Interception

![Graph showing light interception over time with different plant heights (20 in, 40 in, 60 in). The x-axis represents dates from 7/2 to 8/31, and the y-axis represents light interception in percentage (%). The graph illustrates the increase in light interception as the plants grow and mature.](Image)
Row Spacing

• Ken Kelley (Parsons) found that soybean yields generally were 0 to 6 bushel greater with narrower row spacing
  – Average difference was approximately 2.5 bu/a
  – Not a consistent difference between 7.5” and 15”
• Work done at ISU suggest that 15” rows out yielded 30” rows 4.5 bu/a on average
Row Spacing

<table>
<thead>
<tr>
<th>Year</th>
<th>KS</th>
<th>MN</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>+3.5</td>
<td>+2.5</td>
</tr>
<tr>
<td>2013</td>
<td>+6</td>
<td>+0.5</td>
</tr>
</tbody>
</table>

Yield (bu ac\(^{-1}\))

- **Narrow**: 7.5” or 10”
- **Medium**: 15” or 20”
- **Wide**: 30”

Haverkamp et al.
Row Spacing

At R2 growth stage: soybean roots expand to span the distance of 30” rows

– Moisture conservation between the rows is exhibited
  • Saved for critical yield producing growth stages
Interactions of Light and Water with Plant Population

Grain Yield (% of Max)

- Light Limiting Region
- Optimal Region
- Water Limiting Region

Increasing Plant Population
Soybean Populations

Test average < 30 bu/a
(24 bu/a)

Roozeboom et al.
Soybean Populations

30 < Test average < 40 bu/a
(36 bu/a)

Yield (% of average)

Plants per acre

Roozeboom et, al.
Soybean Populations

40 < Test average < 50 bu/a
(43 bu/a)

Roozeboom et al.
% Establishment vs. Seeds per acre
Plant Uniformity

Duncan, KSU, 2007
Stand uniformity – Silver Lake Non-irrigated

Duncan, KSU, 2007
Seed Fungicide Treatment

• Planting prior to soil temperatures exceeding 60° F is discouraged

• K-State recommendations are to use fungicide treated seed if:
  – Planting conventionally tilled prior to mid-May or
  – Planting no-till prior to Memorial Day

• Seed fungicide treatments generally provide greater final plant population
Soybean Plant Populations

- Trend greater plant survival with fungicide seed treatments
  - Untreated 76% emerged
  - Fungicide 84% emerged (range of 8% to 41% improvement)

![Seed Treatment Effect on Plant Population](chart)

- Untreated
- Fungicide
- Fungicide + Insecticide

$p = 0.24$
Soybean Inoculation, 2001

Scandia site was irrigated, no soybeans in that field for 9+ years. Geary Co. was dryland, soybeans were planted 2 years prior. Manhattan was dryland with no soybeans for the last 5 years.
Rescue N on Soybeans August 3

![Bar graph showing Yield (bu/a) vs Nitrogen Rate (lb/a)]

- **LSD₀.₁₀ = 3.7**
Inoculation Suggestions

• Inoculation is important for soybeans going to “virgin” ground with no history of prior soybean plantings.
  – Probably advisable if soybeans have not been grown for the past decade ie. Coming out of CRP/Grass sod

• May also consider inoculating when:
  – Flooded soils, low pH, sandy soils with low organic matter

• Protect inoculated seed and inoculant from excessive heat

• Since inoculation may not be fool proof, the use of planter box inoculants in addition to seedsman applied may be in order

• If nodulation fails, rescue N applications can be profitable
Flower, Pod and Seed Abortion
High-yielding soybean

Can we increase yields by reducing abortion?

50% Abortion

WE CAN HAVE 50% ABORTION IN FLOWERS AND 50% IN PODS AND STILL GET 60 BU/A

Ciampitti et al. Egli et al.
High-yielding soybean

Can we increase yields by reducing abortion?

Early pod expansion is the most susceptible to drought stress

Soil Water Status is a major player in regulating final pod set

Liu et al. 2004
High-yielding soybean

Can we increase yields by reducing abortion?

Eternal Optimist! = produces ↑ flowers than it can sustain

↑ FLOWERS and ↑ PODS (↓ ABORTION) will not necessarily be reflected in higher YIELDS if the plant is not fixing more Carbon.

↓ ABORTION will not change YIELDS, but ↓ seed weight will (i.e. drought or other stress limiting growth)
Soybean water use or daily evapotranspiration (ET) from a well-watered soybean crop

- Irrigation around the R2-R3 growth stage can have one of the biggest effects on yield
Irrigation

• Maintaining soil water content around 50-60%

— While the biggest impact on yield is irrigation around the R2/R3 grow stage, additional yield determining factors are critical after that period
“Short” moisture stress on soybean yield

<table>
<thead>
<tr>
<th>Growth Stages</th>
<th>SOYBEAN</th>
<th>yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; week flowering</td>
<td>R1</td>
<td>8%</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt; week flowering</td>
<td>R2</td>
<td>19%</td>
</tr>
<tr>
<td>4&lt;sup&gt;th&lt;/sup&gt; week of flowering</td>
<td>R3</td>
<td>36%</td>
</tr>
<tr>
<td>2&lt;sup&gt;nd&lt;/sup&gt;-4&lt;sup&gt;th&lt;/sup&gt; week of seed filling</td>
<td>R4</td>
<td>39-45%</td>
</tr>
<tr>
<td>5&lt;sup&gt;th&lt;/sup&gt; week of seed filling</td>
<td>R5</td>
<td>12%</td>
</tr>
</tbody>
</table>

Wright et al. 2006 – Univ. of Minnesota
## Irrigation

General Soybean Growth and Water Use (agriculture.org)

<table>
<thead>
<tr>
<th>Crop Development</th>
<th>Water Use (in/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination and seeding</td>
<td>0.05 - 0.10</td>
</tr>
<tr>
<td>Rapid vegetative growth</td>
<td>0.10 - 0.20</td>
</tr>
<tr>
<td>Flowering to pd fill (full canopy)</td>
<td>0.20 - 0.30</td>
</tr>
<tr>
<td>Maturity to harvest</td>
<td>0.05 - 0.20</td>
</tr>
</tbody>
</table>
Soybean Yield Anomalies and Temperature: Midwest

Correlation between June and August average temperatures and soybean yield anomalies between 1982-1998 (17 years).

- About 32% of yield variation was explained by temperature during June to August
- This is critical period of soybean yield determination

Canopy Temperature

- Since 1960, yield has increased 0.33 bu/a/year
- Cooler canopy temperatures during grain fill of $C_3$ plants result in increased seed yield
- Since 1980, canopy temperatures have been reduced by about 3.5°F

Keep and Schapaugh, KSU
Late Season Nitrogen Needs
Soybean Nitrogen Accumulation

- Cumulative nitrogen for corn occurs earlier and more rapid than for soybean
  - 50% Soy Nitrogen accumulation at R4
- Nodule function decreases after R5.5

Research from: (Hanway and Weber, 1971)
Soybean Nitrogen Accumulation

- Still 20% of the total N uptake comes after R5.5.
- The main N contribution comes from "Fixed N".

FOR EXAMPLE:
40 bu./A Soybean
30 lbs N/A (after R5.5)
Late Season N Applications

- The nitrogen demands during R4-R6 may be greater than what is available
- Multiple types of N applied at R3 in KS across 8 site years
  - Significant yield increase at 6 of 8 locations
    - Average 6.9 bu/ac

Wesley et al., 1998
Summary

- There are numerous practices producers can implement to manage soybean yield
  - Tillage, rotation, plant date, row spacing, seed rate
  - However 80% of the management is complete when the seed is put in the ground
- Not every practice mentioned will effect yield in any particular year
  - Optimizing available growing season resources (water, light, time) will help drive yield
Questions

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