Maximizing Soybean Yields

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1) DuPont Pioneer 2) Univ. of Arkansas
Acknowledgments

• Arkansas Soybean Promotion Board
• DuPont Pioneer
• Grower Cooperators
  – Kip Cullers
  – Dow Brantley
  – Michael Taylor
  – Stan Haigwood
Outline

- Introduction
  - Current production levels
- Research at Kip Cullers’ & small-plots in Fayetteville
  - Methods
  - Yield results
  - Additional treatments
- Large-scale strip trials in the Delta
- How to grow 100 bushels in SE Kansas
Current Yield Record

- Mr. Kip Cullers, Missouri Soybean Association
  - 2006 – **139** bu/ac
  - 2007 – **155** bu/ac
  - 2008 – **118** bu/ac
  - 2009 – N/A
  - **2010 – 161** bu/ac
  - 2011 – **109** bu/ac
  - 2012 – N/A
  - 2013 – **115** bu/ac

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Research with Mr. Cullers

• Establish four “plots” within each variety
  – Radiation use efficiency (RUE)
  – N accumulation rate
  – Rate of harvest index (HI) increase and seed fill duration
  – Leaf N during seed fill
  – Yield and components
Research in Fayetteville

- Establish maximum yield environment
- Plots 30ft x 4 rows, center 20ft for yield, RCBD with 4 replications
- Characterize 12-14 varieties of 4.2 to 5.5 RM from Pioneer, Asgrow and NK
Cullers’ Management

- Rotates between two contest fields of Newtonia silt loam
- Perennial poultry litter applications
- Fertigation
Cullers’ Management

- Rotates between two contest fields of Newtonia silt loam
- Perennial poultry litter applications
- Fertigation
- Early planting
- Modest plant density ~140,000 plants/ac
- 9 inch twin rows on 30 inch centers
- Indeterminate Pioneer Hi-Bred varieties from 4.2 – 5.1 RM
- Frequent (daily) overhead irrigation
- Multiple seed treatments, herbicides, insecticides, fungicides, and others…
Fayetteville Management

- Soil test + 200 bu yield goal (250 lbs Potash, 250 lbs K-Mag)
- 5 or 7.5 dry tons/ac poultry litter
- N, K, & S fertigation
- Sprinkler irrigation @ 1 in. deficient (26”)
- Early planting
- 18 inch rows
- 140,000 plants/ac
- Deep tillage ≥ 14 in.
- Preventative fungicides
- Strict pest control
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Cullers’ Yield 2011

Yield (bu/ac)

<table>
<thead>
<tr>
<th>Year</th>
<th>Yield</th>
<th>Letter</th>
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<tr>
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<td>94Y82</td>
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<tr>
<td>94Y92</td>
<td>78.8</td>
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</table>
Fayetteville Yield 2012

Yield (bu/ac)

P94Y23  AG5332  P94Y80  P94Y81  AG4907  S46-U6  AG4303  AG5503  AG4531  P94Y82  S44-K7  S49-A5

A  A  A  A  B  B  B  B  C  C  C  C

115  107  106  105  104  100  99  97  96  96  95  86
Cullers’ Yield 2013

Yield (bu/ac)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Yield</th>
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<tr>
<td>49T97</td>
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<tr>
<td>48T53</td>
<td>103</td>
</tr>
<tr>
<td>50T40</td>
<td>92</td>
</tr>
</tbody>
</table>
Fayetteville 2013
Yield Components

- **Cullers’ 2011-13**
  2900 seeds per lb

- **Fayetteville 2012-13**
  2800 seeds per lb

USA avg. 2012 & 13: 2800 seeds per lb

Seeds m\(^{-2}\): 3600

USA avg. 2012 & 13: 1700 seeds m\(^{-2}\)

**More PODS**
Anything affecting crop growth affects photosynthate production.

Early flowering lengthens seed set and decreases seed sugar demand per plant.

After all stresses eliminated, light becomes the limiting factor.

Seed Number Determination

\[
\text{Seed number} = \frac{\text{Total crop photosynthate}}{\text{Sugar needed per seed}}
\]
2012 Growing Season

Daily Incident Radiation (MJ m⁻²)

VE | R1 | Beg. R5 | R7

12-Apr | 2-May | 22-May | 11-Jun | 1-Jul | 21-Jul | 10-Aug | 30-Aug | 19-Sep
Leaf N Dynamics

2013

R² = 0.92

Leaf N Concentration (%)

Days Before (-) and After (+) R5

-40 -20 0 20 40 60

-3 -2 -1 0 1 2 3 4 5 6

- ■ 94Y82
- ■ 95Y10

Image of soybean plants
Conclusions

• Distinctive physiological characteristics provide insights for unusually high soybean yields

• Management practices create unique maximum yield environment

• Weather conditions remain influential on yield
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Burn Treatments, 2011-13

- Applied at V3
- Early morning with dew to increase injury
- Products & rates:
  - 0.5 oz/ac Aim + NIS
  - 0.9 oz/ac Cadet + NIS
  - 12.5 oz/ac Cobra + NIS
  - 12.5 oz/ac Cobra + 2% crop oil
  - 12.5 oz/ac Cobra + 0.5 oz/ac Aim + 2% crop oil

Yield (bu/ac)

- Untreated Check: 100
- Cobra: 91
- Cobra + CO: 94

Non-significant
2013 Burn Treatments

2013 Yield (bu/ac)

- Untreated Check: 102 (B), 129 (A)
- Aim: 94 (C), 108 (A)
- Cadet: 98 (B), 104 (C)
- Cobra: 95 (C), 97 (D)
- Cobra+CO: 92 (C), 98 (B)
- Cobra+ Aim+CO: 72 (E), 93 (C)

Notations:
- A, B, C, D, E represent different treatments or conditions.
Seed Treatments

- “Untreated” (came with fungicide/insecticide)
- Optimize 400 (2x rate)
  - Novozymes, Bradyrhizobium + lipo-chitooligosaccharide (LCO), “biological molecule stimulates cell division & growth”
- Bio-Forge
  - Stoller, N,N'-diformyl urea, “upregulate anti-oxidative pathways, reduce plant stress”
- Accolade-(P)
  - INTX Microbials, Azospirillum brasilense, free-living N₂ fixing bacteria
- Treated control – all of the above
Seed Treatments, 2011-13

Yield (bu/ac)

- "Untreated" Control: 95
- Accolade only: 92
- Optimize only: 94
- Bio-Forge only: 97
- Treated Control: 100

Non-significant
Even Spacing or Emergence

- No response to even intra-row spacing or even height

- Likely due to soybean’s ability to “flex”
Conclusions

- No single practice increased yield beyond described maximum yield management:
  
  - Soil test + 200 bu yield goal
  - 5 to 7.5 dry tons/ac poultry litter
  - N, K, & S fertigation
  - Sprinkler irrigation @ 1 in. deficient (26”)
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Objective

• Demonstrate management practices for high soybean yield in large production fields
  – Reach 100 bu/ac without significantly increasing input costs
Two (2011) or three (2012-13) location in Eastern Arkansas

Five or six Pioneer cultivars
  – 4.2 to 5.1 RM
  – Indeterminate
  – Glyphosate resistant

Randomized 1-acre strips with 5-6 replications
Management

• Supplemental poultry litter (~1.5 dry tons/ac)
• Early planting (March 29-April 25)
• Row widths ≤ 30”
• Timely irrigation
• Strict pest management
  – Pre-plant residual + post herbicides
  – Reduced insect action thresholds
  – Two preventative fungicides
• 50 lbs N at R4 & R5.5 (2012-13)
2012 Lessons
<table>
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<th>England</th>
<th>Helena</th>
<th>Newport</th>
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<td>76 C</td>
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<td>46T21</td>
<td>103 A</td>
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<td>94Y70</td>
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Economic Costs

- Costs above growers’ normal practices

- “Normal practices” in nearby fields were 8 to 9 bu/ac less

- $10/bushel = $80 to $90 response per acre

<table>
<thead>
<tr>
<th>Product</th>
<th>Cost (per acre)</th>
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<tbody>
<tr>
<td>Poultry litter</td>
<td>$ 80</td>
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<tr>
<td>Urea</td>
<td>$ 75</td>
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<td>2nd Fungicide</td>
<td>$ 20</td>
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<td>Defoliant</td>
<td>$ 15</td>
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<td><strong>Total</strong></td>
<td><strong>$ 190</strong></td>
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Break-even Yield Response

Bushels to Break Even vs. Grain Price ($ per bu)

- The graph shows a downward trend, indicating that as grain prices increase, the number of bushels required to break even decreases.
- At a grain price of $8 per bushel, approximately 20 bushels are required to break even.
- At a grain price of $18 per bushel, approximately 10 bushels are required to break even.

Graphical representation: A downward-sloping line connects data points, illustrating the relationship between grain price and bushels to break even.
Other considerations

- Poultry litter benefit to soil and subsequent crops
  - Transportation cost
- 2\textsuperscript{nd} late-season fungicide bad IPM
- Inconsistent yield response to N

\textbf{Per acre:}

\begin{tabular}{|l|r|}
\hline
Poultry litter & $80 \\
Urea & $75 \\
2\textsuperscript{nd} Fungicide & $20 \\
Defoliant & $15 \\
\hline
\textbf{Total} & $190 \\
\hline
\end{tabular}
Conclusions

- **Early planting & narrow rows** to maximize light interception and set more pods
- **Irrigation, fertility & pest control** to minimize stresses and keep more pods
- **Don’t forget basics** (variety selection, rotation, pH…)
- **N₂ fixation** most profitable
- **Attention to detail & timing** crucial
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Management in SE Kansas

- Variety Selection
- Planting Date (earlier the better)
- Fertility (Require 4 lbs K$_2$O per bushel)
- Row Spacing (≤15 in.)
- Soil Management (pH, water holding capacity)
- Fungicide/Insecticide Seed treatments
- Crop Rotation
- Pest Management (weeds, diseases, insects)
- Weather
Thank You