Increased Soybean Seeding Rates vs. Preemergence Herbicide Use

Ryan DeWerff, Dr. Vince Davis, Dr. Shawn Conley
Background

- Soybean seed cost has dramatically increased since the mid 1990’s

Source: (USDA ERS 2013)
Background

- Economic realities and improved genetics are driving a reduction in soybean seeding rates
- Current recommendations are to establish a stand of 247,000 plants ha\(^{-1}\)
- Lower seeding rates can slow canopy development
- Crop canopy closure aids in weed suppression
- Preemergence (PRE) residual herbicides may be more necessary for weed control in low seeding rate soybean systems
Background

• PRE residual herbicides:
  • Reduce amount of weeds exposed to postemergence (POST) applications
  • Allow for greater flexibility in POST application timing
  • Provide additional effective mode of action for resistance management
  • Protect crop from early-season weed competition
  • Enable quicker canopy closure??
Objective

• Establish the effectiveness of weed suppression by increased seeding rates in relation to PRE residual herbicide control in the context of herbicide resistance management

• Do higher seeding rates reduce number of weeds exposed to POST herbicide?
Methods

• Site Description
  • Two year study near Arlington, WI (2012 & 2013)
  • Field Preparation
    • Fall – chisel plowed
    • Spring – field cultivated
  • Planted mid-May in 38 cm wide rows
• Predominant weeds
  • Setaria faberi
  • Chenopodium album
  • Ambrosia artemisiiifolia
  • Amaranthus retroflexus
Methods

- 2 x 2 x 5 factorial in RCB
  - [2] with or without PRE herbicide
  - [2] POST herbicide programs

<table>
<thead>
<tr>
<th>Herbicide Treatments</th>
<th>Seeding Rate Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE residual</td>
<td>1000 seeds hectare^{-1}</td>
</tr>
<tr>
<td>S-metolachlor+</td>
<td></td>
</tr>
<tr>
<td>fomesafen</td>
<td></td>
</tr>
<tr>
<td>Conventional program</td>
<td></td>
</tr>
<tr>
<td>imazamox fb</td>
<td>High</td>
</tr>
<tr>
<td>fluazifop</td>
<td>470 GR\textsuperscript{a}</td>
</tr>
<tr>
<td>Glyphosate program</td>
<td>Moderate</td>
</tr>
<tr>
<td>glyphosate+</td>
<td>296 GR</td>
</tr>
<tr>
<td>imazamox</td>
<td>High blend</td>
</tr>
<tr>
<td></td>
<td>296 GR</td>
</tr>
<tr>
<td></td>
<td>Low blend</td>
</tr>
<tr>
<td></td>
<td>148 GR</td>
</tr>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>148 GR</td>
</tr>
</tbody>
</table>

\textsuperscript{a}GR = glyphosate-resistant seed

\textsuperscript{b}C = conventional seed
Methods

• Data Collection
  • Weed counts
    • before POST applications
    • before soybean harvest
  • Soybean stand counts
  • Weekly soybean growth staging
  • Weekly canopy closure estimates
    • digital image capture method adapted from (Purcel, 2000. Crop Sci.)
  • Soybean yield adjusted to 13% moisture

• Data Analysis
  • Data were subjected to ANOVA using the Proc Mixed procedure in SAS
  • Means were separated using Fisher’s Protected LSD test at $P \leq 0.05$
  • Weed density data were log transformed
    • Data presented were back transformed
  • Linear regression using the Proc Reg procedure in SAS
Methods

• Canopy closure estimation
  • Images were analyzed with SigmaScan Pro® to determine percent light interception
  • Cumulative intercepted photosynthetically active radiation (CIPAR) values were calculated

\[
\text{CIPAR} = (\text{average solar radiation (MJ m}^{-2}) \times 0.0864 \times 0.5 \times \% \text{ LI}) \text{ summed over a given period of time}
\]

• V1 – R1 (critical period of weed control)
• Glyphosate treatments only

# Weed Density: Seeding Rate

- An increase in soybean population did not influence early or late-season weed growth in most scenarios

## Model: \( y = \beta_1 \times \text{soybean population} + \beta_0 \)

<table>
<thead>
<tr>
<th>Year</th>
<th>Herbicide program</th>
<th>Total Density at POST timing</th>
<th>Total Density at harvest(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>PRE</td>
<td>0.9036</td>
<td>0.5132</td>
</tr>
<tr>
<td></td>
<td>NO PRE</td>
<td>0.0468(^b)</td>
<td>0.6187</td>
</tr>
<tr>
<td>2013</td>
<td>PRE</td>
<td>0.1071</td>
<td>0.0422(^b)</td>
</tr>
<tr>
<td></td>
<td>NO PRE</td>
<td>0.9714</td>
<td>0.2086</td>
</tr>
</tbody>
</table>

\(^a\)Data were log transformed  \(^b\)Did not meet assumptions

- **Exception:** 2012 in plots without a residual herbicide at POST timing
• Exception: 2012

Weed Density = -0.005*Soybean Population + 470.54; R^2 = 0.20

- Weed density decreased by 50.0 plants m^{-2} for each additional increase of 10,000 soybean plants
Weed Density: Residual Herbicide

Weed density at POST timing averaged across years

<table>
<thead>
<tr>
<th>Herbicide Program</th>
<th>Density</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Broadleaves&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Grasses&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Total</td>
</tr>
<tr>
<td>PRE</td>
<td>6</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>No PRE</td>
<td>98</td>
<td>77</td>
<td>188</td>
</tr>
<tr>
<td>Pr &gt; F</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

<sup>a</sup>Broadleaf species included *Chenopodium album*, *Ambrosia artemisiifolia*, and *Amaranthus retroflexus*

<sup>b</sup>Grass species included *Setaria faberi*, *Eriochloa villosa*, and *Digitaria sanguinallis*

• Reduced total number of weeds exposed to POST application by 93%
Canopy at 3 weeks after POST (Soybean R2)

2012: seed rate * residual herbicide (P=0.0014)

With PRE herbicide (top)
- Low (148K seeds/ha): 89% (ab)
- Mod (296K seeds/ha): 92% (a)
- High (470K seeds/ha): 96% (a)

Without PRE herbicide (bottom)
- Low (148K seeds/ha): 54% (c)
- Mod (296K seeds/ha): 81% (bc)
- High (470K seeds/ha): 90% (ab)
2013: seed rate * residual herbicide (P=0.6713)

Canopy at 3 weeks after POST (Soybean R2)

With PRE herbicide (top)

Low (148K) 56% B
Mod (296K) 71% A
High (470K) 79% A

Without PRE herbicide (bottom)

seed rate (P=0.0001)
Yield = 10.748*CIPAR + 1660.883; $R^2 = 0.885$

- CIPAR from V1 to R1 growth stages
- Critical period of weed control (CPWC)
- 10.7 kg ha$^{-1}$ increase in yield for each additional unit of CIPAR
2012 Soybean Yield

Seeding rate by Residual Herbicide Use (P<0.0001)

<table>
<thead>
<tr>
<th>Seeding Rate (1000 seeds ha(^{-1}))</th>
<th>Residual</th>
<th>No Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td>High (470)</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Moderate (296)</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>Low (148)</td>
<td>a</td>
<td>c</td>
</tr>
</tbody>
</table>
Seeding rate by Residual Herbicide Use (P=0.8380)

Seeding rate (P<0.0001)

Yield (kg ha\(^{-1}\))

- **High**: 470
- **Moderate**: 296
- **Low**: 148

Seeding Rate (1000 seeds ha\(^{-1}\))

- Residual
- No Residual
Implications: Yield

- Soybean canopy closure is important to maximize yield
  - Higher seeding rates = quicker canopy closure (2013)
  - Early-season weed competition can delay canopy closure later in the season (2012)
  - Residual herbicides can maximize canopy development by limiting early-season weed competition
    - Especially important at low seeding rates
  - Lower seeding rates can increase risk of yield loss from weed competition if resources are limited (2012 drought)
    - A high seeding rate was necessary to maximize yield when soybean was subjected to high early season-weed competition (i.e. no residual herbicide)
    - Residual herbicides can reduce risk
Implications: Resistance Management

• Increased seeding rates may **NOT** be an effective method for herbicide resistance management
  • Did not reduce number of weeds exposed to POST applications
  • Did not reduce end of season weed densities
  • **Exception:** higher soybean populations decreased weed density prior to POST application in 2012

• Residual herbicides
  • Limited the number of weeds exposed to the POST herbicides by 93%
  • Reduced end of season weed densities
Acknowledgements

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Thank You!

Questions?