Assessing Risk and Return on Investment of Fungicide and Insecticide Soybean Seed Treatments

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University of Wisconsin, Madison
Agronomic Realities of U.S. Soybean Production a Benchmarking Project

Average planting date

Planting date (week)
- <May 1st
- May 1st
- May 2nd
- May 3rd
- May 4th
- June 2nd
- >June 2nd

Average seeding rate (thousand seeds/acre)

- 180 - 200
- 160 - 180
- 140 - 160
- 120 - 140
- 100 - 120

% of fields with seed treatment

- 80% - 100%
- 60% - 80%
- 40% - 60%
- 20% - 40%
- 0% - 20%

Grassini et al. 2016; N=3386
Lots' of Options...Who Wins?

- Years (2011-2013) \( N = 2,880 \)
- RCBD 3x8 factorial (4 reps)
- Seed Treatments (8)
- Varieties (3)
  - Pioneer 92Y30
  - Asgrow 2332
  - Syngenta 21-N6
- Row Spacing: 15 inch
- Planting Date: First 3 weeks in May
- Seeding Rate: 140,000 seeds a\(^{-1}\)

**Seed Treatments (8)**
- Syngenta Cruiser platform
- Monsanto Acceleron platform
- Bayer Trilex/Evergol & P/V platform

**Neonicotinoids included**
- Thiamethoxam
- Clothianidin
- Imidacloprid

<table>
<thead>
<tr>
<th>Seed treatment trade name(s)</th>
<th>Seed treatment code†</th>
<th>Pesticide component‡</th>
<th>Active ingredients (a.i.)</th>
<th>Application rate Mg a.i. seed⁻¹</th>
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<tbody>
<tr>
<td>ApronMaxx® AM</td>
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<td>fludioxonil (F)</td>
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<td>thiamethoxam (I)</td>
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<td>Gauchó® 600 + Poncho®/VOTIVO</td>
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<td>* Bacillus pumilus (F)</td>
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<td>EverGol™ Energy + Poncho®/VOTIVO</td>
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<td>mefenoxam (F)</td>
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<tr>
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<td>thiamethoxam (I)</td>
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<td></td>
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<td>clothianidin (I)</td>
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<td>* Bacillus firmus (N)§</td>
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<td></td>
<td>* Bacillus firmus (N)§</td>
<td>0.0213</td>
<td></td>
</tr>
</tbody>
</table>
Statistical Analysis

• Seed treatment effects on plant stand and seed yield
• Mix model analysis
  – **Fixed effects**: seed treatment or pesticide component
  – **Random effects**: environment, variety, and replicate

### Analysis Structure

- **2011-2012**
  - **Analysis of the eight individual seed treatments**

- **2013**
  - Pesticide Component Analysis
    - UTC
    - Fungicide only (F)
    - Fungicide + Insecticide (FI)
    - Fungicide + Insecticide + Nematicide (FIN)

- **2011-2012**

- **2013**
Results: Plant Stand 2011-2012

$P < 0.0001$

Values followed by the same letter are not significantly different at $p \leq 0.10$
Results: Seed Yield 2011-2012

\[ P = 0.06 \]

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

- UTC
- AppronMaxx
- CruiserMaxx
- Avicta Complete
- Trilex
- Trilex+Gaucho+Poncho/Votivo
- Acceleron F
- Acceleron FI

Yield values range from 56 to 68 bu a\(^{-1}\).
Results: Plant Stand 2011-2012

\( P < 0.0001 \)
Results: Seed Yield 2011-2012

\[ P = 0.0115 \]

<table>
<thead>
<tr>
<th>Pesticide Components</th>
<th>Yield (bu a(^{-1}))</th>
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<tbody>
<tr>
<td>UTC</td>
<td>56</td>
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<tr>
<td>F</td>
<td>58</td>
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<td>FI</td>
<td>60</td>
</tr>
<tr>
<td>FIN</td>
<td>62</td>
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<td></td>
<td>64</td>
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<tr>
<td></td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>68</td>
</tr>
</tbody>
</table>
Results: Plant Stand 2013

$P < 0.0001$

Plant Stand (1000 plants a$^{-1}$)

- UTC
- AppronMaxx
- CruiserMaxx
- Avicta Complete
- EverGol Energy
- EE + Poncho/Votivo
- Acceleron F
- Acceleron F1

Legend:
- $a$
- $b$
- $c$
- $cd$
- $de$
- $e$
Results: Seed Yield 2013

$P = 0.0002$

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (bu a$^{-1}$)</th>
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</thead>
<tbody>
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<tr>
<td>AppronMaxx</td>
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<td>Avicta Complete</td>
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<td>EverGol Energy</td>
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<td>EE + Poncho/Votivo</td>
<td>66</td>
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<tr>
<td>Acceleron F</td>
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<tr>
<td>Acceleron F1</td>
<td>68</td>
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</tbody>
</table>

Letters indicate significant differences in yield.
Results: Plant Stand 2013

\[ P < 0.0001 \]
Results: Seed Yield 2013

\[ P = 0.006 \]

<table>
<thead>
<tr>
<th>Pesticide Components</th>
<th>Yield (bu a(^{-1}))</th>
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</thead>
<tbody>
<tr>
<td>UTC</td>
<td>60</td>
</tr>
<tr>
<td>F</td>
<td>62</td>
</tr>
<tr>
<td>FI</td>
<td>66</td>
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<tr>
<td>FIN</td>
<td>68</td>
</tr>
</tbody>
</table>
Economic Risk and Profitability of Soybean Fungicide Insecticide Seed Treatments at Reduced Seeding Rates

- Years (2012-2013) N =1296
- Regions
  - Southern
  - Central
  - N. Central
- Variety: NK Brand S20Y2
- Planting Date: First 3 weeks in May
- Row Spacing: 15 inches
- Seed treatments
  - UTC
  - ApronMaxx RFC (0.0094 mg ai seed⁻¹)
  - CruiserMaxx (0.0858 mg ai seed⁻¹)
- Seeding rates
  - 40, 60, 80, 100, 120, 140 (1000 seeds a⁻¹)

Main Effect: Seeding Rate

$LSD (.05) = 1.2$ bu a$^{-1}$

Yield (bu a$^{-1}$)

Seeding Rate (1000 seeds a$^{-1}$)
BeanCam Replant Decision App.

You see this

The app sees this
Replant Decision App.

Instantly review results

<table>
<thead>
<tr>
<th>Estimated Population</th>
<th>% of Max Yield (current)</th>
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<tbody>
<tr>
<td>80327</td>
<td>97</td>
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</table>

<table>
<thead>
<tr>
<th>Replant Rate</th>
<th>% of Max Yield (if replanted)</th>
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<tr>
<td>59673</td>
<td>98</td>
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</table>

<table>
<thead>
<tr>
<th>Average Frost Date</th>
<th>Configuration Settings</th>
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<tr>
<td>1-Oct</td>
<td>V1 / 15&quot;</td>
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</table>
Main Effect: Seed Treatment

$LSD (.05) = 0.84 \text{ bu a}^{-1}$
Yield at Various Seeding Rates for Different Seed Treatments

$LSD (.05) = 2.1 \text{ bu a}^{-1}$

Yield (bu a$^{-1}$)

Seeding Rate (1000 seeds a$^{-1}$)
## CIPAR & CumNDVI

### Planting Date x Seed Treatment

- Delaying planting decreases CIPAR & CumNDVI
- CruiserMaxx increased CIPAR & CumNDVI within first planting date.

Table 7. CIPAR and CumNDVI means for the planting date by seed treatment interaction pooled across all seeding rates at Arlington, WI during 2012 and 2013.

<table>
<thead>
<tr>
<th>Seed treatment</th>
<th>Planting date</th>
<th>Early</th>
<th>Mid</th>
<th>Late</th>
<th>Avg.</th>
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<tbody>
<tr>
<td></td>
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<td>UTC†</td>
<td></td>
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<tr>
<td>CIPAR, MJ m⁻²</td>
<td></td>
<td>631</td>
<td>599</td>
<td>541</td>
<td>590</td>
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<tr>
<td>ApronMaxx</td>
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<td>631</td>
<td>601</td>
<td>542</td>
<td>591</td>
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<tr>
<td>CruiserMaxx</td>
<td></td>
<td>645</td>
<td>606</td>
<td>544</td>
<td>598</td>
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<tr>
<td>LSD (0.05)</td>
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<td>11</td>
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<tr>
<td>Avg.</td>
<td></td>
<td>635</td>
<td>602</td>
<td>542</td>
<td></td>
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<tr>
<td>CumNDVI‡</td>
<td></td>
<td>UTC</td>
<td></td>
<td></td>
<td></td>
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<td>ApronMaxx</td>
<td></td>
<td>33.8</td>
<td>30.9</td>
<td>27.9</td>
<td>30.9</td>
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<tr>
<td>CruiserMaxx</td>
<td></td>
<td>35.2</td>
<td>31.2</td>
<td>28.6</td>
<td>31.7</td>
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<tr>
<td>LSD (0.05)</td>
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<td>0.8</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Avg.</td>
<td></td>
<td>34.4</td>
<td>31.0</td>
<td>28.2</td>
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</tbody>
</table>

†UTC, untreated control
‡CumNDVI, has no units for measurement because it is a relative number.

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SDS: An Unintended Partner of Early Planted Soybeans

- *Fusarium virguliforme* causes sudden death syndrome of soybean

- Delaying planting has shown to reduce SDS symptoms, but it can also reduce soybean yield

*F. virguliforme* spores
Target Specific Seed Treatments

- Fungicide + insecticide seed treatments target a wide array of soybean pathogens and insect pests

- Fluopyram (ILeVO) seed treatment from Bayer CropScience
  - Seed treatment specifically targeted for SDS and SCN

Questions?
- Does Fluopyram provide additional yield, profit, and economic risk benefits to the base fungicide + insecticide seed treatment program ± F.v. presence?
- How do recent grain price declines impact seeding rate and seed treatment decisions?
- What is the risk associated with reducing seeding rates?
Trial Information

- RCBD 2 x 3 x 6 factorial or split plot with 4 reps
- Varieties used: AG2136, RS213NR2, AG2636
- Six seeding rates (seeds a\(^{-1}\))
  - 40,000
  - 60,000
  - 80,000
  - 100,000
  - 120,000
  - 140,000 (current WI rec.)

- Three seed treatments
  - UTC
  - CB (Commercial Base)
    - Prothioconazole (F)
    - Penflufen (F)
    - Metalaxyl (F)
    - Clothianidin (I)
    - Bacillus firmus (N)
  - ILeVO
    - CB (FIN)
    - Fluopyram (F)
## Seed Treatment Breakdown

<table>
<thead>
<tr>
<th>Seed treatment code †</th>
<th>Seed treatment trade name(s)</th>
<th>Active ingredients (a.i.) ‡</th>
<th>Application rate mg a.i. seed⁻¹</th>
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<tbody>
<tr>
<td>UTC</td>
<td>n/a</td>
<td>-</td>
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<td>EverGol™ Energy +</td>
<td>prothioconazole (F)</td>
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<tr>
<td>CB</td>
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<td>penflufen (F)</td>
<td>0.0041</td>
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<tr>
<td>CB</td>
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<td>metalaxyl (F)</td>
<td>0.0066</td>
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<tr>
<td>CB</td>
<td>Allegiance FL +</td>
<td>metalaxyl (F)</td>
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<tr>
<td>CB</td>
<td>Poncho®/VOTiVO®</td>
<td>clothianidin (I)</td>
<td>0.1074</td>
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<tr>
<td>CB</td>
<td></td>
<td>Bacillus firmus (N)</td>
<td>0.0218</td>
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<tr>
<td>ILeVO</td>
<td>EverGol™ Energy +</td>
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<td>penflufen (F)</td>
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<tr>
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<tr>
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<td>ILeVO®</td>
<td>fluopyram (F)</td>
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</table>

† Seed treatment code represents the unique combination of active ingredients. The letters/numbers were used for coding each seed treatment.

‡ F: fungicide; I: insecticide; N: nematostat.
• Data was broken into 6 different data sets as follows:
  – WI All, contains all WI locations, regardless of SDS symptomology
  – WI SDS, contains WI location with visual SDS symptomology (7/20 LOCATIONS)
  – IA, IN, MI and ON locations all displayed visual SDS symptomology but were analyzed separately due to experimental designs differences.
Yield Potential: Locations

- We examined treatments across various yield potentials and ultimately, responsive and non-responsive environments
  - WI = 20 environments
  - IA = 2 environments
  - IN = 1 environment
  - MI = 1 environment
  - ON = 2 Environments

☆ = Location displayed visual SDS symptomology
Early Season Plant Stand (V2)

**Graph Description:**
- **Y-Axis:** Early Season (V2) Plant Stand (plants ha⁻¹)
- **X-Axis:** WI All, WI SDS, IA, IN, MI, ON
- **Legend:**
  - UTC
  - CB
  - ILeVO

**Data Analysis:**
- The graph compares the early season plant stand across different locations (WI All, WI SDS, IA, IN, MI, ON) for UTC, CB, and ILeVO treatments.
- Bars with different letters (a, b, c) indicate significant differences in plant stand density among the treatments.
- The highest plant stand densities are observed in the CB treatment across most locations, followed by ILeVO, with UTC showing the lowest densities.
Main Effect: Seed Treatment

Yield (bu a⁻¹)

- UTC
- CB
- ILeVO

<table>
<thead>
<tr>
<th>Region</th>
<th>WI All</th>
<th>WI SDS</th>
<th>IA</th>
<th>IN</th>
<th>MI</th>
<th>ON</th>
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<tr>
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<td></td>
<td></td>
<td></td>
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</table>
Main Effect: Seeding Rate

<table>
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<th>LSD (0.05)</th>
<th>WI All</th>
<th>WI SDS</th>
<th>IA</th>
<th>IN</th>
<th>MI</th>
<th>ON</th>
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<tr>
<td>0.9</td>
<td>1.5</td>
<td>2.6</td>
<td>10.2</td>
<td>5.7</td>
<td>8.9</td>
<td></td>
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</tbody>
</table>

Yield (bu a⁻¹)
Yield at Various Seeding Rates for the Different Seed Treatments

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

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

UTC, \(R^2 = 0.95\), S.E. = 1.52
CB, \(R^2 = 0.96\), S.E. = 1.33
ILeVO, \(R^2 = 0.97\), S.E. = 1.28
Economic Risk

• Uncontrollable factors during planting and early season growth

• Products and practices that are valuable:
  – Show consistent yield gains
  – Provide profit stability over a wide range of situations and environments
  – Help manage long term margins and economic risk with volatile grain markets

• Assessing economic risk at various seeding rates and how seed treatment affects risk
  – “Base case” = 140k seeds a⁻¹ with no seed treatment (UTC)
  – Our trial allows us 20 comparisons to the base case.
  – The break-even probability shows us the probability that a certain seeding rate x seed trt. combination will increase profit over the base case.
    o Or essentially the risk of a certain treatment combination
<table>
<thead>
<tr>
<th>Treatment combination</th>
<th>Seed Treatment Rate</th>
<th>Break-even probability</th>
<th>Avg. profit increase over the Base Case</th>
</tr>
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<tr>
<td></td>
<td>Seeds $a^{-1}$</td>
<td>$a^{-1}$</td>
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<tr>
<td></td>
<td></td>
<td>Positive outcomes</td>
<td>All outcomes</td>
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<tr>
<td></td>
<td></td>
<td>$a^{-1}$</td>
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<td>UTC</td>
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<td>0.99</td>
<td>4</td>
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<tr>
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</table>
Assessing causes of yield gaps in agricultural areas with diversity in climate and soils

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University of Nebraska-Lincoln
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Assessing causes of yield gaps

US soy area is ± 85 million a and the ~30% of global soybean production

North-Central US region represents the ~80% US soybean production

Potential yield: 90 bu/ac
Actual gap: 45 bu/ac

Main goal
To benchmark current yield and management practices in producer fields across the North-Central US region in order to identify KEY management factors that can help producers to increase yield and input-use efficiency
Location of surveyed 2014-2015 soybean fields

Number of fields: 3568
Data collection: survey form

Contact info and logos were customized for each state

<table>
<thead>
<tr>
<th>PRODUCER NAME:</th>
<th>MAILING ADDRESS:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Please provide information for four SOYBEAN fields on your farm in 2014. If you have questions, contact Professor Patricio Grassini (Phone: 402-472-5554 / e-mail: pgrassini2@unl.edu). Note that all provided info will be kept confidential! An EXAMPLE is shown in red.

**Example:**

<table>
<thead>
<tr>
<th>2014 Soybean</th>
<th>2014 Soybean</th>
<th>2015 Soybean</th>
<th>2015 Soybean</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE 1/4</td>
<td>NW 1/4</td>
<td>NE 1/4</td>
<td>NW 1/4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Specify field location by Section: Township: Range.

Please sketch-in the boundaries of your field location within the Section.

OR GPS coordinates of field centroid:

41.678, -100.257
Saunders Co., SW of Rd 11 & N

Dryland? OR Pivot, Gravity? Indicate field size (acres)
Pivot (130 ac)

Does this field have drainage? (no, old clay tile, new systematic tile, surface drainage, other)
No

Total inches of Irrigation Applied to crop?
5 Inches

SOYBEAN YIELD (bushels/acre) for this FIELD:

Low: 70
High: 80

Lowest (High) yield (bu/ac) of your soy fields that year
Low: 41
High: 51

*Use Irrigated fields yield range if this crop was irrigated

*Use Dryland fields yield range if this crop was Dryland

Planting Date in this FIELD (Month/Day/Year):

5/15/2014

**EXAMPLE:**

<table>
<thead>
<tr>
<th>2014 Soybean</th>
<th>2014 Soybean</th>
<th>2015 Soybean</th>
<th>2015 Soybean</th>
</tr>
</thead>
<tbody>
<tr>
<td>发射 (137 ac)</td>
<td>发射 (84 ac)</td>
<td>发射 (111 ac)</td>
<td>发射 (111 ac)</td>
</tr>
<tr>
<td>发射 (38 ac)</td>
<td>发射 (38 ac)</td>
<td>发射 (38 ac)</td>
<td>发射 (38 ac)</td>
</tr>
</tbody>
</table>

Variety Name (Brand & Number):
Pioneer P93M11

Seeding Rate (seeds/acre): 125,000

Row spacing (inches): 30

Seed Treated (Yes/No)? What Brand Name Product(s)?
Yes (Crusier-Max)

Prior Crop in this FIELD? Residue harvested or grazed?
Corn - Grazed

Tillage after prior crop? No-Till (NT); Ridge (RT); Strip (ST);
Disk (D); Chisel (C); Vertical (V)—Indicate timing (month-year)
ST (March-2014)

Any (non-starter) fertilizer after prior crop?
Yes (N, P, Zn)

Specify rate (pounds NUTRIENT/acre) and timing (month-year)
Other: 5 (11 lbs)

Any STARTER fertilizer (Yes/No)? If Yes, specify nutrients
Yes (N, P, Zn)

Any Lime (L) or Manure (M)? If yes, specify timing (mm-yy)
M (Nov-2013)

PRE- or POST-emergence herbicide program or BOTH?
Both

Any In-season foliar fungicide (F) / Insecticide (I)?
F and I

Soy Cyst Nematodes (Yes/No/I don’t know)?
No

Iron Deficiency Chlorosis (Yes/No)?
No

Any significant yield loss due to Insects, Diseases, Weeds, Frost, Hall, Flood, Lodging? Specify problem
Frost (Sept-2014)

- Field location
- Field boundaries
- Irrigation type and amount
- Drainage type
- Field yield
- Yield range
- Planting date
- Variety
- Seeding rate
- Row spacing
- Seed treatment
- Tillage
- Fertilizer
- Starter
- Lime, Manure
- Herbicide
- Fungicide
- Insecticide
- SCN, IDC, others
Materials and Methods

- Average pH values for topsoil (0-12 inches) and subsoil (12-60 inches) for each field were derived from the SSURGO database.

- To account for differences in slope and terrain across field, which could influence the crop water balance, we calculated average values of topography wetness index (TWI) for each field.

- Fields with large TWI values would be associated with greater water supply and fertility compared with fields with lower values.
How to make fair comparisons among fields?

We hypothesize that collecting producer field data is equivalent to running field experiments to capture responses to management factors IF fields are properly contextualized relative to climate and soil.

Rainfed field in central NE
- Annual rainfall: (24 in)
- Soil type: silt loam

Rainfed field in central IA
- Annual rainfall: (35 in)
- Soil type: clay loam
Materials and Methods cont.

- Briefly, TED framework delineates regions based on:
  (i) annual total growing degree-days,
  (ii) aridity index,
  (iii) annual temperature seasonality, and
  (iv) plant-available water holding capacity in the rootable soil depth.

- Each TED corresponds to a specific combination of the four parameters.
Surveyed fields were clustered in 10 TEDs; each TED contains > 90 fields.
For SD ~ 4.5 bu/ac we need 100 observations to detect a 3 bu/ac yield difference due to a management practice with power=0.8

We will have > 1000 samples.
Results TED=1R
Results TED=2R
Results TED=2R

TED=2R

Row space p = 0.005

Narrow

Medium, Wide

On-farm soybean yield (bu/ac)

n=36

58.5 bu/ac

n=82

64.5 bu/ac
Results TED=6R
Results TED=6R

TED=6R

Sowing date
p < 0.001

112-141
Seed treatment
p = 0.01

Yes

Nematodes
p = 0.024

No

Yes, Unknown

Tillage
p = 0.034

No-till, Reduced
Conventional

On-farm soybean yield (bu/ac)

n = 19
60 bu/ac

n = 17
69 bu/ac

n = 40
63 bu/ac

n = 30
66 bu/ac

n = 47
55.5 bu/ac
A new generation of soybean cyst nematode is born every 24 days during summer. Many overpower resistant soybeans. All will cut yield potential.

What’s your number?
Take the test. Beat the pest.
The SCN Coalition™
Funded by the soybean checkoff
www.coolbean.info

@badgerbean

thesoyreport.blogspot.com
Pooled Herbicide Trait Performance Across Southern, Central and North Central WI 2017

![Bar graph showing yield comparison between RR2X (124/219 varieties) and RR2Y (95/219 varieties). A p-value of 0.005 indicates a statistically significant difference. RR2Y is 2 bu higher.]

p-value=0.005

+ 2 bu RR2Y

Yield (bu/A)

RR2X (124/219 varieties)

RR2Y (95/219 varieties)
Pooled White Mold Incidence at ARL, HAN, & CHIP FALLS Sites Across Herbicide Traits 2017

![Map of Soybean Variety Test Locations]

- **A**: 
  - White Mold (% of diseased plants)
  - p-value = 0.003
  - + 8% RR2X
  - Average White Mold = 29%

- **B**: 
  - RR2X (124/219 varieties)
  - RR2Y (95/219 varieties)

[COOL BEAN:
University of Wisconsin-Madison | UW Extension]

[Website: WWW.COOLBEAN.INFO]
2017 Regional Starred Varieties as % of Varieties in Each Event

Regions and Events

- South RR2Y
- South RR2X
- Central RR2Y
- Central RR2X
- North-Central RR2Y
- North-Central RR2X

Percent (%)

- RR2Y
- RR2X