## Yield Losses – Northern US

<table>
<thead>
<tr>
<th>Disease</th>
<th>3-year average (bu in millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean cyst nematode</td>
<td>122.4</td>
</tr>
<tr>
<td>Phytophthora rot</td>
<td>42.1</td>
</tr>
<tr>
<td>Seedling diseases</td>
<td>41.1</td>
</tr>
<tr>
<td><strong>Sudden death syndrome</strong></td>
<td>22.7</td>
</tr>
<tr>
<td>Charcoal rot</td>
<td>17.6</td>
</tr>
<tr>
<td>Brown spot</td>
<td>16.2</td>
</tr>
<tr>
<td>Brown stem rot</td>
<td>14.1</td>
</tr>
<tr>
<td>Anthracnose</td>
<td>11.3</td>
</tr>
<tr>
<td>Sclerotinia stem rot</td>
<td>10.0</td>
</tr>
<tr>
<td>Frogeye leaf spot</td>
<td>7.6</td>
</tr>
<tr>
<td>Fusarium root rot</td>
<td>7.6</td>
</tr>
</tbody>
</table>

Source: Allan Wrather, University of Missouri, Portageville, MO
SCN Is a Serious Threat!

Widespread Distribution

Lack of Symptoms

Prolific Reproduction

Long-Term Survival

Damage Potential

McGawley  Tylka
Soybean Cyst Nematode

• Three different surveys have shown that approximately 75% of fields in Missouri have soybean cyst nematode (SCN).

• New Survey of Missouri SCN in 2015
SCN Egg Count Densities

**2005 (n=122)**

- None (0) 10%
- Low (1-500) 4%
- Medium (500-10,000) 48%
- High (10,000+) 38%

**2015 (n=100)**

- None (0) 7%
- Low (1-500) 4%
- Medium (500-10,000) 14%
- High (10,000+) 77%
## 2015 Survey

<table>
<thead>
<tr>
<th>Region</th>
<th>County</th>
<th>HG Type</th>
<th>Race</th>
<th>Peking Fi %</th>
<th>88788 Fi %</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE</td>
<td>Perry</td>
<td>2-</td>
<td>5</td>
<td>5</td>
<td>23</td>
</tr>
<tr>
<td>SE</td>
<td>Bollinger</td>
<td>2-</td>
<td>1</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>SE</td>
<td>Cape Girardeau</td>
<td>2-</td>
<td>5</td>
<td>5</td>
<td>54</td>
</tr>
<tr>
<td>SE</td>
<td>Scott</td>
<td>1.2-</td>
<td>2</td>
<td>34</td>
<td>60</td>
</tr>
<tr>
<td>SE</td>
<td>Scott</td>
<td>1.2-</td>
<td>2</td>
<td>33</td>
<td>62</td>
</tr>
<tr>
<td>SE</td>
<td>Butler</td>
<td>1.2-</td>
<td>2</td>
<td>41</td>
<td>62</td>
</tr>
<tr>
<td>SE</td>
<td>Mississippi</td>
<td>1.2.3-</td>
<td>4</td>
<td>65</td>
<td>56</td>
</tr>
</tbody>
</table>

## 2005 Survey

<table>
<thead>
<tr>
<th>County</th>
<th>Eggs</th>
<th>HG Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butler County</td>
<td>61200</td>
<td>HG 1.2.5.7</td>
</tr>
<tr>
<td>Mississippi County</td>
<td>51750</td>
<td>HG 1.2.5.7</td>
</tr>
<tr>
<td>New Madrid County</td>
<td>33750</td>
<td>HG 1.2.5.7</td>
</tr>
<tr>
<td>Scott County</td>
<td>141375</td>
<td>HG 2.5.7</td>
</tr>
<tr>
<td>Stoddard County</td>
<td>88000</td>
<td>HG 1.2.5.7</td>
</tr>
</tbody>
</table>
Management of Nematodes

Resistant soybean
Non-host crop rotation
Scouting/Monitoring
6-Year Crop Rotation Sequence

Year 1
SCN Resistant Soybean
(1st source of resistance, e.g. 88788)

Year 2
Nonhost Crop
(e.g. Corn)

Year 3
SCN Resistant Soybean
(2nd source of resistance, e.g. Hartwig)

Year 4
Nonhost Crop
(e.g. Corn)

Year 5
SCN Resistant Soybean
(1st source of resistance, e.g. back to 88788 but a different variety)

Year 6
Nonhost Crop
(e.g. Corn)
Three root knot species affect soybeans

• Genus *Meloidogyne*

• Southern root knot- *M. incognita*

• Peanut root knot- *M. arenaria*

• Javanese root knot- *M. javanica*
Scouting for SCN

1. Collect soil samples
2. Any time of year, but fall/winter best
3. Send soil samples to diagnostic clinic

SCN Diagnostics
1721 E. Campus Loop
Columbia, Mo. 65211
Phone
(573) 884-9118

http://scndiagnostics.com/
Scouting for Root Knot

1. August - October
2. Dig roots and look for galls
3. Collect soil samples
4. Send soil samples to diagnostic clinic

SCN Diagnostics
1721 E. Campus Loop
Columbia, Mo. 65211
Phone
(573) 884-9118

http://scndiagnostics.com/
Current Nematode Seed Treatment Products

- **Avicta** - abamectin
  - natural fermentation product of *Streptomyces avermitilis*
  - inhibits nematode nervous system

- **VOTiVo** - *Bacillus firmis*
  - biological - possibly a repellant, physical or chemical barrier

- **N-Hibit** - harpin αβ protein
  - suppresses nematode egg production and initiates a complex natural defense

- **Clariva pn1** - *Pasteuria nishizawaiae*
  - direct mode of action on nematodes

- **ILeVo** - fluopyram
  - Group 7 fungicide for SDS w/ nematode activity
Yield (BU/A) of 3 soybean lines differing resistance to SCN & RKN with & without Ilevo

<table>
<thead>
<tr>
<th>Variety</th>
<th>Treated</th>
<th>Untreated</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>S11-20337 R to SCN, RKN</td>
<td>60</td>
<td>54</td>
<td>+6</td>
</tr>
<tr>
<td>S11-20345 R to SCN only</td>
<td>54</td>
<td>41</td>
<td>+13</td>
</tr>
<tr>
<td>S09-17361 Susceptible</td>
<td>34</td>
<td>30</td>
<td>+4</td>
</tr>
</tbody>
</table>

Grover Shannon, 2015
Seedling disease

Pre- and post-emergent ‘damping off’

Causal organisms:

- *Pythium* species
- *Phytophthora sojae*
- *Rhizoctonia solani*
- *Fusarium* species
Soybean Seed Treatment Fungicides

• Selective for “water molds”, i.e. Pythium and Phytophthora
  – Allegiance FL  metalaxyl
  – Apron XL  mefenoxam

• Intego Solo Fungicide  ethaboxam
SDS - *Fusarium virguliforme*  
(= *F. solani f. sp. glycines*)

- Soilborne, root rotting fungus that colonizes tap root and crown
- Produces a mycotoxin(s)
- Foliar symptoms generally start at R2 in field
How SDS Develops

- SDS pathogen can infect the plant within days of seed germination
- The greater the # of fungal spores in contact with the roots the faster root rot appears
- Seedlings are very susceptible to infection
- There is a decrease in susceptibility as plants get older
How SDS Develops

• In cooler soils the roots are susceptible for a longer period of time
• Saturated soils and temperatures of 55-65º F favor infection
• Slow seed germination and emergence prolongs the contact period between pathogen and susceptible soybean roots
Environment

SDS severity is increased with:

- Early planted fields
- Compacted soil
- High moisture, low soil temperature during vegetative growth
- Cool period during flowering
- Presence of soybean cyst nematode

Crop rotations – inconsistent
What impact does SDS have on yield?

• Slight to 100%: 20-30% yield loss common
  – depending on variety and stage of crop development when foliage symptoms occur
• Time of symptom development
  – if after R5 or R6 impact minimal
  – if at flowering may be high impact
• Yield loss not uniform across field
Management

• Properly identify
• Variety Selection
• Stagger and delay planting
• Improve drainage & avoid compaction
• Avoid continuous cropping soybean
• Harvest fields promptly
• **Foliar fungicides are not effective**
• Seed treatment for SDS
  – ILeVo - fluopyram
    • Group 7 fungicide for SDS w/ nematode activity
Look Alikes

Triazole Fungicide

Dectes Stem Borer
Southern stem canker

- Dark brown lesion on one side of lower- to mid-stem
- Interverinal chlorosis of leaves may or may not occur
- Unlike SDS, leaves stick to petioles as plants die

Management: Variety selection and rotation
<table>
<thead>
<tr>
<th>Disease</th>
<th>Roots</th>
<th>Exterior Stem</th>
<th>Interior Stem</th>
<th>Leaf Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>stem canker</td>
<td>healthy</td>
<td>dark red-brown canker at node that can extend over several nodes; lesions often not entirely around stem</td>
<td>discoloration or browning near lesion</td>
<td>interveinal chlorosis and necrosis, typically leaves remain attached to plant</td>
</tr>
<tr>
<td>brown stem rot</td>
<td>healthy</td>
<td>healthy</td>
<td>brown discoloration in pith (center of stem)</td>
<td>interveinal chlorosis and necrosis</td>
</tr>
<tr>
<td>Fusarium wilt</td>
<td>brown vascular tissue</td>
<td>healthy</td>
<td>brown vascular tissue</td>
<td>leaves yellow and wilt, remain attached</td>
</tr>
<tr>
<td>Phytophthora stem rot</td>
<td>root discoloration</td>
<td>dark brown lesion beginning at the taproot and extending up several nodes on the stem and surrounding the entire stem</td>
<td>brown internal discoloration on plants at any stage</td>
<td>leaves yellow and wilt, remain attached</td>
</tr>
<tr>
<td>sudden death syndrome</td>
<td>root discoloration and rotting; internal browning of tap root</td>
<td>healthy</td>
<td>brown or gray discoloration in below outer stem layer but pith is white</td>
<td>interveinal chlorosis and necrosis of leaves, leaves drop after death</td>
</tr>
<tr>
<td>tobacco streak virus</td>
<td>healthy</td>
<td>dark red-brown canker at node(s) - not always present</td>
<td>brown discoloration of the pith at node(s)</td>
<td>healthy; bud proliferation and plants stay green after maturity</td>
</tr>
<tr>
<td>white mold (Sclerotinia stem rot)</td>
<td>healthy</td>
<td>white cottony mold stuck to lower stem, black, hard sclerotia may be present</td>
<td>black sclerotia embedded in stem tissue</td>
<td>leaves wilt and turn grayish green between veins, remain attached</td>
</tr>
</tbody>
</table>
Cercospora leaf spot vs. potassium deficiency
Frogeye leaf spot
“Sporulating” lesions
Confirmations of QoI-resistant *Cercospora sojina* isolates were made by the Bradley lab (Univ. Illinois), or the Kelly lab (Univ. Tennessee).

Soybean leaf samples were collected by university and extension plant pathologists from several states.
Management of Frogeye

• Variety Selection - *Rcs3* gene for resistance
• Properly identify – MU Diagnostic Lab resource
• Strobilurin (Group 11) fungicide tolerance is an issue.
  – Avoid spraying one mode of action
Target Spot
Target Spot

• First appears on lower leaves after canopy closure
• Defoliates bottom canopy and in severe cases middle and upper canopy
• Moisture and heat driven
• Like septoria brown spot, typically stays in lower canopy with minimal yield impact.
• Fungicides not generally recommended
Southern Corn Rust
Common Rust (no obvious halos)

Pustules (uredinia)
- orange
- circular-oval
- upper leaf surface

Environment
- “tropical weather” ≥80°, high humidity and moist conditions

Southern Rust (yellow halos)

Pustules (uredinia)
- cinnamon
- elongate
- both leaf surfaces

Environment
- cooler temperatures <80° and moist conditions
“Puccinia Pathways”

Image courtesy USDA-ARS
Southern Corn Rust
Explosive Disease

- Disease cycle – 10 days
- 5000 spores per pustule
- 1,300 pustules per leaf
- 26,000 plants per acre
- >2.5 trillion spores per acre
Management of Rust

• Variety Selection for Common Rust
  – Can play a minor role for Southern Rust

• Follow the Puccinia pathway
  – IPM PiPe website: http://www.ipmpipe.org/

• Scout and properly identify
  – MU Diagnostic Lab resource

• Fungicide application timing critical

• Yield loss associated with early onset of disease
Welcome Dr. Kaitlyn Bissonnette

• Field Crops Plant Pathologist
• bissonnettek@missouri.edu
Questions?