Managing the Soybean Cyst Nematode

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Iowa State University
Department of Plant Pathology and Microbiology
The soybean cyst nematode (SCN) is the most damaging soybean pathogen in North America

<table>
<thead>
<tr>
<th>Pathogen / disease</th>
<th>Allen et al. 2010-2014 estimates – rank in US*</th>
</tr>
</thead>
<tbody>
<tr>
<td>soybean cyst nematode</td>
<td>1</td>
</tr>
<tr>
<td>sudden death syndrome</td>
<td>2</td>
</tr>
<tr>
<td>seedling diseases</td>
<td>3</td>
</tr>
<tr>
<td>Phytophthora stem &amp; root rot</td>
<td>4</td>
</tr>
<tr>
<td>charcoal rot</td>
<td>5</td>
</tr>
<tr>
<td>Septoria brown spot</td>
<td>6</td>
</tr>
<tr>
<td>Sclerotinia stem rot</td>
<td>7</td>
</tr>
<tr>
<td>brown stem rot</td>
<td>8</td>
</tr>
<tr>
<td>Fusarium wilt and root rot</td>
<td>9</td>
</tr>
<tr>
<td>pod and stem blight</td>
<td>10</td>
</tr>
</tbody>
</table>

Severe symptoms of SCN damage – central Iowa
Typical yield loss with severe symptoms

- **Yield (bushels per acre)**
  - Resistant: 71.0
  - Susceptible: 35.8

- **50% yield loss**
  - 35.2 bushels / acre yield difference

Absence of symptoms of SCN damage – central Iowa
Typical yield loss with no symptoms

10% yield loss
7.0 bushels/acre yield difference

Yield (bushels per acre)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Yield (bushels per acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistant</td>
<td>78.8</td>
</tr>
<tr>
<td>Susceptible</td>
<td>71.8</td>
</tr>
</tbody>
</table>

Whether symptoms are absent or severe

or

SCN
Known SCN–Infested Counties – 2017

34 new since 2014:
- Alabama = 1
- Georgia = 3
- Indiana = 1
- Iowa = 1
- Kansas = 3
- Kentucky = 3
- Minnesota = 2
- Missouri = 1
- New York = 1
- N. Carolina = 4
- N. Dakota = 7
- Ohio = 3
- S. Dakota = 1
- Virginia = 2
- Wisconsin = 1
- Quebec = 1
Random Surveys of Iowa for SCN (~200 fields each year)

- 1996–97: 74% of fields SCN+
- 2007–08: 72% of fields SCN+
- 2017–18: 63–86% of fields SCN+

Sample points 1996–1997

1990s funded by
NCSRP

2000s funded by
Iowa Soybean Association

2010s funded by
industry
SCN–resistant Soybean Varieties

SCN–susceptible soybean variety

$0.00 extra

SCN–resistant soybean variety

Photo: University of Minnesota
Yield and SCN Control
SCN–resistant vs Susceptible Soybean Varieties

East Central Iowa
(1,310 eggs/100 cm³ at planting)

<table>
<thead>
<tr>
<th>Yield</th>
<th>Resistant</th>
<th>Susceptible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>52.7</td>
<td>45.9</td>
</tr>
</tbody>
</table>

+6.8 bu/acre
Yield and SCN Control
SCN–resistant vs Susceptible Soybean Varieties

East Central Iowa
(1,310 eggs/100 cm³ at planting)
Number of SCN–resistant Soybean Varieties Available for Iowa 1991 – 2017

Iowa State University Extension, Ames.
Sources of SCN Resistance for Breeding

- PI 548402 (Peking)
- PI 88788
- PI 90763
- PI 437654

- PI 209332
- PI 89772
- PI 548318 (Cloud)

All are agronomically undesirable due to flat viny growth, black seed coat, late maturity, etc.
good agronomic soybean variety
- vigorous, upright growth
- high yielding
- appropriate maturity group
- susceptible to SCN

breeding line as source of resistance
- not vigorous
- flat growth
- low yielding
- black seed coat
- late maturity group
- SCN resistant

Desired Offspring
- vigorous, upright growth
- high yielding
- appropriate maturity group
- resistant to SCN
Number of SCN–resistant Soybean Varieties Available for Iowa 1991 – 2017

Iowa State University Extension, Ames.
Number of SCN–resistant Soybean Varieties Available for Iowa 1991 – 2017

- PI 88788
- other 6 sources

Significantly less difficult to produce high yield/SCN resistant plants than with other sources of resistance

Desired Offspring:
- vigorous, upright growth
- high yielding
- appropriate maturity group
- resistant to SCN

What happens when a single herbicide is used for 20 years???

Glyphosate-susceptible (left) and glyphosate-resistant (right) common ragweed populations three weeks after application of 44 oz/acre of Roundup PowerMax.

Source: University Nebraska–Lincoln CropWatch
Iowa State University SCN-resistant Soybean Variety Trial Program 1991 – present

funded in part by

**Table 1. Newell (SW Iowa) Glyphosate-resistant.**

<table>
<thead>
<tr>
<th>Brand</th>
<th>Variety</th>
<th>Relative matur.</th>
<th>Resistance</th>
<th>IDC</th>
<th>SCN Rnk1</th>
<th>SCN Rnk2</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Latham</td>
<td>L3188R2</td>
<td>2.8</td>
<td>2.0</td>
<td>2.1700</td>
<td>7.2</td>
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<tr>
<td>3 Tux</td>
<td>34238</td>
<td>3.1</td>
<td>2.3</td>
<td>2.5</td>
<td>1.6950</td>
<td>9.4</td>
</tr>
<tr>
<td>3 Tux</td>
<td>5S302X</td>
<td>3.1</td>
<td>2.2</td>
<td>2.3</td>
<td>2.7750</td>
<td>6.0</td>
</tr>
<tr>
<td>3 Tux</td>
<td>ANGRW</td>
<td>3.1</td>
<td>2.0</td>
<td>2.1</td>
<td>3.0500</td>
<td>6.5</td>
</tr>
<tr>
<td>3 Tux</td>
<td>NL B</td>
<td>3.1</td>
<td>2.0</td>
<td>2.0</td>
<td>4.5000</td>
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<tr>
<td>3 Tux</td>
<td>Dyna-Gro</td>
<td>3.1</td>
<td>3.0</td>
<td>1.7</td>
<td>1.0250</td>
<td>2.1</td>
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<td>3 Tux</td>
<td>Legacy Seeds</td>
<td>3.1</td>
<td>3.1</td>
<td>2.0</td>
<td>4.3350</td>
<td>20.1</td>
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<tr>
<td>3 Tux</td>
<td>Conner</td>
<td>CB30BR44</td>
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<td>LG Seeds</td>
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<td>2.2500</td>
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<td>2.2</td>
<td>3.5500</td>
<td>3.3</td>
</tr>
<tr>
<td>3 Tux</td>
<td>AGROW</td>
<td>3.1</td>
<td>2.0</td>
<td>2.0</td>
<td>3.3750</td>
<td>3.6</td>
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<tr>
<td>3 Tux</td>
<td>FVAGROW</td>
<td>3.1</td>
<td>2.0</td>
<td>2.0</td>
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<td>3.6</td>
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<td>2.0</td>
<td>2.0</td>
<td>3.5500</td>
<td>3.6</td>
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<td>3 Tux</td>
<td>McConaw</td>
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<td>2.0</td>
<td>2.0</td>
<td>3.5500</td>
<td>3.6</td>
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<tr>
<td>3 Tux</td>
<td>Legacy Seeds</td>
<td>3.1</td>
<td>2.0</td>
<td>2.0</td>
<td>4.7750</td>
<td>20.3</td>
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<tr>
<td>3 Tux</td>
<td>Champion</td>
<td>3X15N</td>
<td>2.0</td>
<td>2.0</td>
<td>5.0750</td>
<td>20.0</td>
</tr>
<tr>
<td>3 Tux</td>
<td>FL504</td>
<td>H143330</td>
<td>3.1</td>
<td>2.0</td>
<td>3.1350</td>
<td>9.1</td>
</tr>
</tbody>
</table>

1 Final SCN egg population density (eggs per 100 c.c. soil); values were no significant differences among initial SCN population densities; initial SCN population densities 459.6 eggs per 100 c.c. soil, IDC type 1.25 (44% on PS 86/86, 13% on PS 83).

2 Reproductive factor (RF) = average final SCN egg population density / average initial SCN egg population density; RF 1.0 = no change in SCN population density over growing season.

3 Least significant difference: values are from Fisher’s least-significant-difference test; NS = no significant differences among the varieties.
Survey of reproduction of SCN populations on PI 88788

From 1991 to 1999, almost all SCN populations in our farmer cooperators' fields reproduced below 10% on PI 88788.

SCN population from every farmer cooperator's field is tested on PI 88788 and Peking.

Funded in part by the Iowa Soybean Association.

Reproduction of SCN populations on PI 88788

Each data point represents the SCN population in a field in which a variety trial field experiment was conducted.

McCarville et al. 2017. Plant Health Progress
Reproduction of SCN populations on PI 88788

Each data point represents the SCN population in a field in which a variety trial field experiment was conducted.

McCarville et al. 2017. Plant Health Progress
Reproduction of SCN populations on Peking

Each data point represents the SCN population in a field in which a variety trial field experiment was conducted.
Prospects for the Future

- usefulness of traditional PI 88788 SCN resistance will continue to decline
Number of SCN–resistant Soybean Varieties Available for Iowa 1991 – 2017

Number of varieties

- PI 88788
- other 6 sources

Prospects for the Future

- usefulness of traditional PI 88788 SCN resistance will continue to decline
- new varieties with non-PI 88788 resistance not likely

Photo: University of Minnesota

$0.00 extra

susceptible soybean variety

PI 88788 resistant soybean variety
## Nematode-protectant Seed Treatments

<table>
<thead>
<tr>
<th>Brand name</th>
<th>Crop(s)</th>
<th>Targeted nematodes</th>
<th>Active ingredient</th>
<th>Mode of action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avicta® Complete</td>
<td>cotton, corn, soybean</td>
<td>all ppn</td>
<td>abamectin</td>
<td>inhibits nerve transmission</td>
</tr>
<tr>
<td>N-HIBIT</td>
<td>all</td>
<td>all ppn</td>
<td>harpin protein</td>
<td>bolsters natural plant defenses</td>
</tr>
<tr>
<td>VOTiVO</td>
<td>cotton, corn, soybean</td>
<td>all ppn</td>
<td><em>Bacillus firmus</em></td>
<td>repels nematodes from roots</td>
</tr>
<tr>
<td>Clariva™ pn</td>
<td>soybean</td>
<td>SCN</td>
<td><em>Pasteuria nishizawae</em></td>
<td>nematode parasite</td>
</tr>
<tr>
<td>ileVO</td>
<td>soybean</td>
<td>SCN, RKN, reniform, lesion</td>
<td>fluopyram</td>
<td>SDHI enzyme inhibitor</td>
</tr>
<tr>
<td>NEMASTRIKE</td>
<td>cotton, corn, soybean</td>
<td>SCN, RKN, reniform, lesion</td>
<td>tioxazafen</td>
<td>mitochondrial translation inhibitor</td>
</tr>
<tr>
<td>AVE®</td>
<td>corn, soybean</td>
<td>SCN, reniform, lesion</td>
<td><em>Bacillus amylo-liquefaciens</em></td>
<td>under investigation</td>
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</tbody>
</table>
Seed Treatments and SCN

<table>
<thead>
<tr>
<th>SCN control</th>
<th>Yield increase</th>
<th>No yield increase, no effect on SCN</th>
<th>No yield increase, reduced SCN</th>
<th>Yield increase, reduced SCN</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCN control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
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</tr>
</tbody>
</table>

- No yield increase, reduced SCN
- Yield increase, reduced SCN
- No yield increase, no effect on SCN
- Yield increase, no effect on SCN
Small-plot experiments

- always compare nematode-protectant seed treatment to base fungicide/insecticide seed treatment, not to untreated seed
- 4-row-wide x 17-feet-long plots; 12 reps of each of two treatments
- always on SCN-resistant soybean varieties sold by the company aligned with the seed treatment
- soybean yield and beginning and end-of-season SCN numbers measured for every plot
- funded in part by the Iowa Soybean Association (ISA)
- coordinated and shared seed with ISA On-Farm Network®
Small-plot seed treatment experiments conducted at various locations

- Avicta: 8 site-years ‘11–‘12
- Votivo: 8 site-years ‘11–‘12
- Clariva: 31 site-years ‘14–‘17
- Ilevo: 27 site-years ‘15–‘17
- Aveo: 9 sites ‘17
- Nemastrike: 6 sites ‘17

no effect on SCN or yields
very few effects on SCN or yields ‘14–‘16
more data in ‘17
first data coming in ‘17

funded in part by

[Image: Iowa Soybean Association logo]
Small-plot experiments – Ilevo 2017

* means are significantly different, P<0.10
Small-plot experiments – Aveo 2017

* means are significantly different, P<0.10

funded in part by

IOWA SOYBEAN Association
Small-plot experiments – Nemastrike 2017

* means are significantly different, P<0.10

funded in part by

IOWA SOYBEAN Association
Managing SCN Moving Forward

- scout and sample fields to assess situation – **know your numbers**
- grow nonhost crops (like corn)
- grow resistant soybean varieties – both PI 88788 and Peking
- explore using nematode-protectant seed treatments
- cover crops?? (possible, usefulness yet to be determined)

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www.soybeancyst.info
www.soybeanresearchinfo.com