



# BEAT SCN RESISTANCE

New active approach saves yield



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# Groups unite to combat SCN

*As more soybean cyst nematodes become resistant to SCN-resistant varieties, the SCN Coalition calls for active SCN management*

By CSD staff

**Twenty years ago, the first** SCN Coalition brought together public and private researchers from 10 Midwest states and Ontario, Canada. It was led by expertise and initial funding from the North Central Soybean Research Program (NCSRP)—to find a solution for yield-robbing soybean cyst nematode.

Good news, it worked. Soybean breeders developed SCN-resistant varieties, using the PI 88788 source of resistance, which kept SCN from stealing yield. Farmers had a good solution, and all was well.

Until it wasn't.

"This program helped, as we got SCN under control in the '90s and early 2000s by growing PI 88788 resistant varieties," says Iowa State nematologist Greg Tylka. "The downfall is that all these PI 88788 resistant

**What's your number?**

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varieties had the same set of resistance genes, so due to overuse we no longer farm in a world where SCN is well controlled by PI 88788."

## New national effort launched

Once again, a new SCN Coalition also plans to succeed, thanks in part to initial funding by the farmer-supported Soybean Checkoff and the leadership of the checkoff organizations (see sidebar story, Page 5). To launch the SCN education efforts, we hope you find great value in these

pages, as well as on the detailed website, TheSCNcoalition.com—all designed to help you 'Know Your Number' and actively manage soybean cyst nematode.

As we talked to the core sponsors of this 32-page SCN special insert in Corn+Soybean Digest, their passion for the SCN Coalition and helping farmers overcome valuable yield loss to SCN became obvious.

## Syngenta

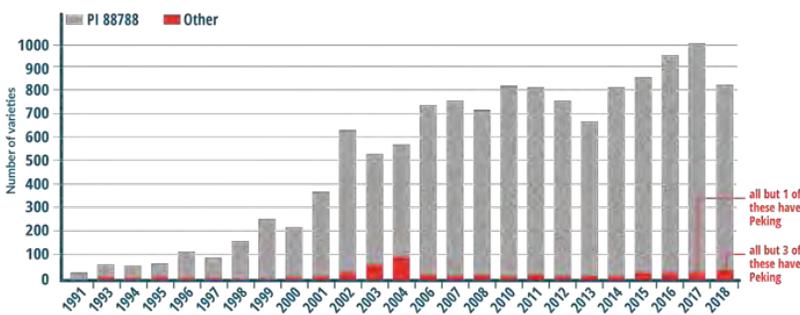
Syngenta researcher Palle Pederson, together with scientists George Bird (Michigan State), Sam Markell (North Dakota State), Albert Tenuta (OMAFRA), Greg Tylka (Iowa State) and others, were instrumental in rebuilding this public-private SCN Coalition. "It's great to have the SCN Coalition back together to educate and illuminate just how much this pest takes away from U.S. farmers," says Dale Ireland, technical product lead for Syngenta's corn and soybean seed treatments.

"It's going to take a multi-pronged approach—from soil tests, rotating crops and rotating SCN-resistant genetic sources to using seed treatments—to truly halt yield loss from SCN."

## Pioneer/Corteva

Pioneer supports the SCN Coalition, as it brings together the best and brightest public sector nematologists and researchers to shed light on this destructive billion-dollar pest, says Pat Arthur, soybean category leader for Pioneer. "We share a common goal to help increase the productivity

Number of SCN-resistant soybean varieties available for Iowa (1991-2018)



Very few commercial soybean varieties are described as SCN susceptible these days.

©Tylka, G. L. and Mullaney, M. P. 2018. Soybean cyst nematode-resistant soybeans for Iowa. Extension Publication PM 1649, Iowa State University, Ames.

Too much of a good thing, over time, can go bad with overuse. Here is Iowa State's annual list of SCN-resistant varieties, representative of many Midwest states. As you can see, 95% of all varieties carry the PI 88788 source of resistance.

Back in the summer of 1998, Soybean Digest led the charge of the first SCN Coalition with a special report that kicked off the campaign “Take the test, beat the pest.” Now, 20 years later, the new SCN Coalition takes aim again.

of farmers, just as we have been a longtime leader producing improved SCN-resistant varieties with both the PI 88788 and Peking sources of resistance.”

### **Bayer Crop Science**

The public-private partnership within the SCN Coalition is vital to communicate the importance of controlling SCN, which almost silently robs more than 120 million bushels per year from U.S. soybean farmers, says AJ Hohmann, Bayer Crop Science marketing manager for Acceleron. “We know a major



issue with SCN is education, and we must do a better job as 57% of farmers agree that SCN is adapting and overcoming resistance, and only 34% sample and scout soybeans for SCN.”

### **BASF**

“We need extra yield protection against this pest that is becoming more resistant to SCN-resistant varieties, and the SCN Coalition is a great champion to bring together integrated management,” says Jeremiah Mullock, BASF product development manager. “We believe that active soil sampling can help farmers develop a plan to manage this number one soybean pest with crop rotations, resistant varieties and seed treatments,” he adds. ◀

If SCN always showed up like this yellow patch in soybean fields as seen below, then all growers would know their yields were being compromised. Unfortunately, SCN rarely shows visible signs of infection.

# The Soybean Checkoff Impact

In 2016, a small band of determined university scientists armed with data met with Ed Anderson, executive director of the North Central Soybean Research Program (NCSRP). They proposed to bring back the SCN Coalition and turn up the volume on SCN resistance management.

But to accomplish this mission, the coalition needed support to mount a national research and education campaign. “We had an idea, and when the NCSRP got behind the SCN Coalition, that idea became reality,” says Sam Markell, extension plant pathologist with North Dakota State University, one of the leaders of this effort.

The NCSRP, a collaboration of 12 state soybean associations that invest checkoff funds to improve yields and profitability, became the driving force to relaunch the coalition. “SCN is the No. 1 yield-robbing pest in soybeans,” says Anderson. “There’s a clear need to raise awareness and re-elevate urgency among farmers and the soybean industry.”

As NCSRP funding kicked off the new SCN Coalition, the United Soybean Board (USB) delivered important funding needed to expand efforts nationally, and the Grain Farmers of Ontario supported an international expansion. And these initial efforts continued to pay off.

“As we met with potential corporate partners to develop a shared vision of success, these companies greatly respected the fact that U.S. soybean growers had skin in the game,” Markell says.

**NCSRP** NORTH CENTRAL SOYBEAN  
RESEARCH PROGRAM



“I realized the potential impact the SCN Coalition could have for soybean growers when leaders from a half dozen competitive companies sat around a table together and brainstormed ways to help the growers manage this looming disaster, he adds. “This would never have been possible without the vision and support of the soybean checkoff.”

Since then, companies have jumped on board to support everything from grower surveys and Commodity Classic learning sessions to advertising awareness efforts, an educational website and this special section you are reading.

Current partners include university scientists from 27 states and Ontario; NCSRP, USB and several state soybean promotion boards (including Ontario); corporate partners BASF, Bayer, Growmark, Pioneer, Syngenta, Winfield United and media partner Corn+Soybean Digest.

“The impact that a coalition of companies, universities and grower organizations can make when working together is far greater than what we could do if we were working alone,” Anderson adds.



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## Managing Soybean Nematodes in an Evolving Landscape

If it seems like your soybean yields are plateauing, you're not alone. When soybean grower Ron Heck started noticing his yields seemed "off," the culprit surprised him.

"I knew there was yield variability in my fields, but I had no idea how large it was," said Heck, a former American Soybean Association president who has farmed for 44 years.

Heck partnered with university researchers to find answers. "We were all surprised to find out that soybean cyst nematode (SCN) was a major contributor to the yield differences," Heck said.

Destructive nematodes like SCN can slash soybean yields by 30 to 50 percent — all without any above-ground symptoms. These microscopic, parasitic roundworms wreak havoc by penetrating the vascular tissue in plant roots, feeding on cell material and blocking nutrient uptake.

"While insects and weeds are visible pests, nematodes quietly attack your yields and profits without drawing much attention," Heck said.

SCN is a serious challenge, but it's not the only nematode threat. Other pests include root-knot nematodes and reniform nematodes, which are among the most destructive nematodes in the southern United States, especially in cotton-producing areas. Root-knot nematodes induce globular, irregularly shaped galls on soybean roots. These galls can be distinguished from soybean plants' nitrogen-fixing nodules, which are spherical in shape.

Many farmers don't realize that their soybean fields have been invaded by nematodes. These pests can feed off soybean roots for weeks before any above-ground symptoms appear. By then, nematode populations have grown more numerous and much stronger, becoming difficult to control.

The practice of growing SCN-resistant soybean varieties is considered to be the most effective tool for the management of SCN, but it is far from a complete solution. Continued use of the soybean varieties that utilize the same source of SCN-resistant genes (PI 88788) has led to the increased ability of SCN to adapt and reproduce. As with herbicide resistance, reliance on a single SCN-management tool has reduced the technology's effectiveness as the target pest has evolved.

Once in a field, SCN cannot be eliminated, making it essential to actively manage this pest with multiple strategies.

\*Compared to a fungicide/insecticide base seed treatment.



Observation of female nematodes and cysts is an accurate way to diagnose SCN infestation in the field.

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### ACTIVE MANAGEMENT IS ESSENTIAL

The cornerstone of a nematode management program starts with soil sampling. "We've got to sample to know what's going on below ground, because an above-ground inspection is not going to tell us what's going on with nematode populations," said Jason Bond, a professor and plant pathologist at Southern Illinois University.

If soil tests reveal threshold populations of nematodes, try these management strategies:

- 1. Put a rotation plan in place.** Planting a non-host crop, such as corn, wheat or sunflowers, can help reduce nematode populations in your field, especially SCN.
- 2. Plant an SCN-resistant soybean variety.** Seek out higher levels of nematode resistance and diverse sources of nematode protection in soybean varieties, such as Peking genetics.
- 3. Investigate new seed treatments.** While nematode resistance is evolving, so are modern seed treatments that complement resistant soybean varieties. Seed treatments offer added protection against nematodes.

ILeVO® seed treatment from BASF is a broad-spectrum nematicide seed treatment that helps control many harmful nematodes, including SCN, root-knot and reniform. ILeVO seed treatment is active across multiple stages of the nematode development cycle by reducing hatching eggs, by decreasing juvenile mobility and development, and also by reducing nematode reproduction in the seed zone. "ILeVO seed treatment provides a complementary benefit to SCN-resistant varieties by adding another level of protection to kill nematodes," said Jeremiah Mullock, BASF Technical Market Manager.

Seedlings that are protected right from the start develop more vigorous root systems. This leads to stronger, healthier plants that are better able to ward off yield-robbing pests as the crop grows.

"ILeVO seed treatment delivers a consistent yield response in the 2- to 4-bushel-per-acre\* range when targeting nematodes," said Mullock, citing research data collected since 2011. "If you have above-ground symptoms of SDS, as well as nematodes in your fields, this yield advantage with ILeVO seed treatment is 4 to 10 bushels per acre.\*\*"

Using a proven seed treatment is an effective way to bring additional management for nematodes while protecting yield potential. Although there's no way to completely eradicate SCN from a field, there are ways to manage the issues and prevent substantial yield loss.



When nematode infestation becomes severe, soybean plants appear generally stunted with yellowing leaves.

# SCN resists the resistance

*Now failing are the resistant varieties that once fought off soybean cyst nematode for decades*

By CSD staff

## What happens when a group

of longtime university and company researchers share a renewed fear of a crop pest, they regroup as a coalition, and they use the word resistance?

It is often wise to pay attention, and act.

Especially when that pest has been around for decades, is mostly invisible, is resisting genetic resistance, and continues to steal over \$1 billion from farmers as the number one economic soybean pest in North America.

Remember the lesson from repeated use of the same products/genetics on corn rootworm? How about consistent use of the same herbicide chemistry on weeds?

Given these issues, and given the fact that more than 95% of the SCN-resistant soybeans planted since the 1990s are resistant to the same resistance source, PI 88788, what could go wrong?

When you ask longtime Iowa State nematologist Greg Tylka of his biggest fear regarding soybeans and soybean cyst nematode resistance, he emphatically replies, “that 20 years from now we stop growing soybeans in the Midwest because of SCN.”

While SCN isn't currently a death sentence, these tiny white dots of SCN egg-filled females on this soybean root are definitely a chronic health problem for soybeans. Without active management to keep numbers low, this pest will most likely cause yield loss well into the future, because it is so long-lived in the soil.

Extreme? You may think so, but he firmly believes we're on a slow-moving train headed toward a cliff.

“Soybean yields continue to decrease as current SCN varietal resistance from PI 88788 decreases in effectiveness, so I'm doing everything I can, along with our SCN Coalition, to convince farmers and the seed industry that we need to do something different,” he says.

## Farmers assume SCN control

Despite SCN being the number one economic pest in soybeans, it's not the visible problem like resistant weeds. In 2015 survey results with 1,096 farmers in 17 states, only 15% viewed SCN as the number one pest. Regarding scouting and soil sampling for SCN, 94% said they know little or nothing about scouting/sampling for SCN; 45% said it is not important to scout for SCN; and 69% of those who don't scout said SCN is not a serious enough pest to scout.

Regarding SCN resistance management efforts, it appears growers are

planting a resistant variety and assuming they are managing SCN. The survey said 59% were growing SCN-resistant soybean varieties, but 68% of this group did not know the source of resistance. Some growers, 22%, said they were using nematode-protectant seed treatments to manage SCN.

## Active management needed

While SCN isn't currently a death sentence, Tylka tells farmers it's a chronic health problem for their soybean crop—for the rest of their career, and most likely their children's farming career, because it is so long-lived in the soil.

“SCN now requires active management, rather than the passive management of simply growing SCN-resistant varieties that farmers were able to do during the '90s and 2000s,” he adds.

It is a myth that soybean cyst nematode is under control.

While soybeans may not look as visibly damaged by SCN as they did 25 years ago, the yield loss is rising.



## Iowa farmer winning against SCN

Iowa farmer Ron Heck is no longer singing the blues about yield lost to SCN. He got his SCN under control, thanks to the research and rotation strategies he adopted by working with Greg Tylka at Iowa State University.

He “took the test, beat the pest,” using this theme from the first SCN Coalition back in the late 1990s.

Heck dropped his SCN numbers from 30,000 eggs per half-cup of soil to 300 or less now. In those previous SCN hot spots within fields, the yield has gone up by 20 to 30 bushels per acre.

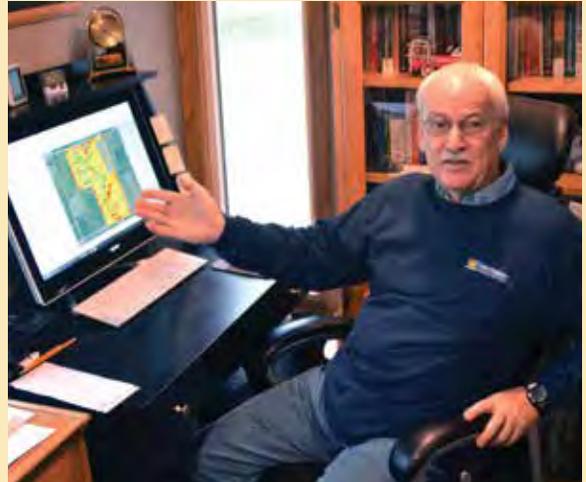
“With SCN you lose at least five bushels an acre before you can even see it. By the time stunting is visible, you’re losing 10 bushels per acre or more,” Heck says. “If you lose five bushels per acre for three or four cycles, you’ve lost a lot of yield.”

### Heck’s rotation success

Sure, there isn’t anything you can do to get rid of your SCN right away. It’s a process. Heck followed this six-year strategy to reduce both SCN yield loss and reduce his egg count:

- Season 1: Plant a PI 88788 resistant soybean variety.
- Season 2: Plant corn.
- Season 3: Come back with a different PI 88788 resistant variety.
- Season 4: Plant corn.
- Season 5: Come back with a Peking resistant variety.
- Season 6: Plant corn.

“Then, on the fourth cycle of soybeans, your yields will be better than you thought possible on



Iowa farmer Ron Heck describes how his yield maps prove he got his SCN under control, thanks to research and rotation strategies. His SCN numbers dropped over time from 30,000 eggs per half-cup of soil to 300 or less. His yields now are easily 10 bu/acre higher on average.

your soybeans,” Heck says. “It’s very important that farmers use other means of control, including Peking resistance and/or the new seed treatments that will help with SCN.”

All of Heck’s soybean fields are healthy now. He doesn’t have the spots where the beans look a little sick and it’s a little bare, with a weed patch. The beans are healthy and growing in every field. “My yields have easily gone up more than 10 bushels an acre on average. And in the worst spots where I used to think it was iron chlorosis, those are now the best spots in the field.”

And damage can occur even in years when we don’t have the hot and dry soils where SCN really thrives.

The nematode-caused stunted root system is just one form of yield loss. Research shows that SCN can cause less nodulation and nitrogen fixation. In fields with both *Fusarium virguliforme* (causes sudden death syndrome or SDS) and SCN, SDS symptoms can develop earlier in the season, increase in severity, and result in

greater yield loss. And there’s a similar increase in the soil fungal disease brown stem rot that can happen when SCN is present.

### Genetic resistance faltering

Surveys by nematologists across the Midwest and Ontario have revealed increased reproduction by nematodes on SCN resistant (PI 88788) soybean varieties. Iowa State has documented a gradual buildup of reproduction of SCN populations in

Iowa on PI 88788 (from 10% in 2000 to 60% and higher now) coupled with decreases in yields of soybean varieties with the PI 88788 source of resistance – up to 14 bu/acre losses in fields that had the highest SCN reproduction. A Missouri survey revealed similar population shifts over the past 3 decades (reproduction on PI 88788 in 1992 was 52%, 2005 was 78%, and 2016 was 100%).

With the prolonged use of PI 88788 resistance (think glyphosate

Some of these microscopic juvenile soybean cyst nematodes now have the ability to invade the roots of SCN-resistant varieties with PI 88788, a resistant source that is used in 95% of the SCN-resistant varieties on the market.

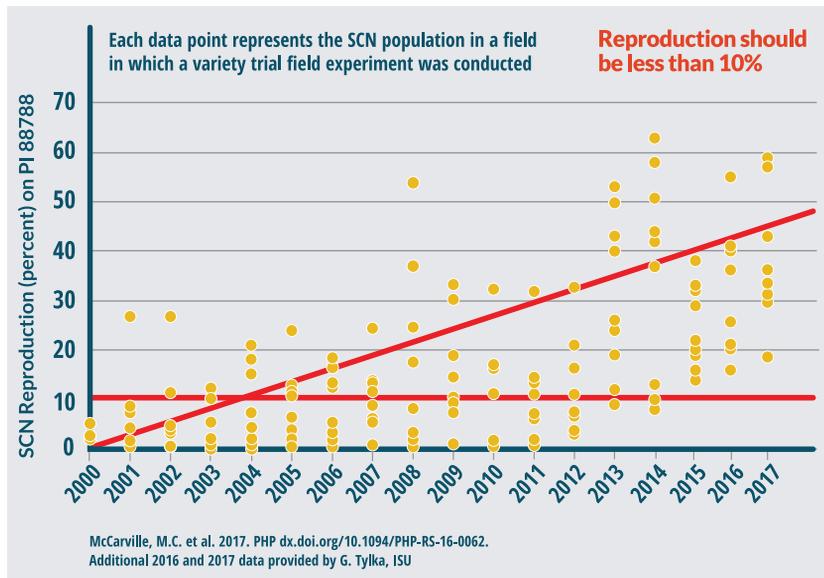
or other herbicide resistance issues), growers have selected for SCN that, over 20 growing seasons, can feed and multiply rapidly on SCN-resistant varieties. A new generation of SCN is born every 24 days during summer. “What might have started out as one SCN resistant worm in a million, now becomes 1 in 3 or 1 in 4. That’s the situation we’re facing not just in Iowa, but across the Midwest, if not the rest of the U.S. and Canada,” Tylka says.



### SCN resistance varies by variety

Tylka cites another myth—that every PI 88788 resistant variety delivers the same nematode control.

### Reproduction of SCN populations in fields has increased on pure PI 88788



Iowa State University (ISU) researchers have been evaluating resistant soybean varieties for 25 years, via annual variety trial experiments in farmers’ fields. Every year researchers take a large soil sample from each farmer’s field and test the nematodes on pure PI 88788 and on PI 548402 (Peking) resistance sources. From 1991 to 1999, almost all SCN populations in Iowa farmers’ fields were well controlled by PI 88788, and reproduction was below 10 percent. But it topped 10 percent beginning in 2001, and spiked above 60 percent in 2014. This is likely happening in almost all Midwestern states.

After 20-plus years of using the same source of resistance, farmers are seeing natural selection in action. The nematodes are adapting. SCN populations are increasingly able to reproduce on varieties with the PI 88788 resistance source. There’s no way to reverse this trend.

To create a new SCN-resistant soybean variety, multiple copies of SCN resistance genes must be transferred from a breeding line like PI 88788 into a susceptible (non-resistant) soybean variety through crossing of plants, a process which is a foundation of plant breeding. And not all of the SCN resistance genes necessarily make it into the new plants resulting from the breeding process when selection for other agronomic characteristics receives priority, hence the differences across SCN-resistant varieties. That is why Iowa State conducts annual field experiments across the state to test hundreds of varieties for their nematode control. Unfortunately, 95% of these varieties contain only one source of resistance (PI 88788).

There are other genetic lines of known resistance to SCN, but most soybean breeders have yet to develop them into varieties. A few companies, Pioneer being the largest, have bred varieties with the Peking resistance line, but yield challenges seem to keep many breeders from adopting this line that isn’t showing any signs of weakness to SCN.

For more details on how to actively manage SCN, read on. ◀

# HOW THE SCN PROBLEM EVOLVED.

## What's your number?

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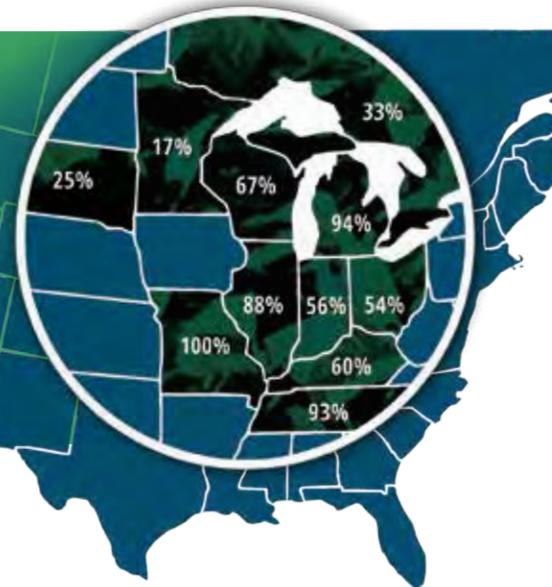
## TOO MUCH of a good thing.

For more than 20 years, greater than 95 percent of all SCN-resistant soybean varieties have included resistance from the PI 88788 breeding line.

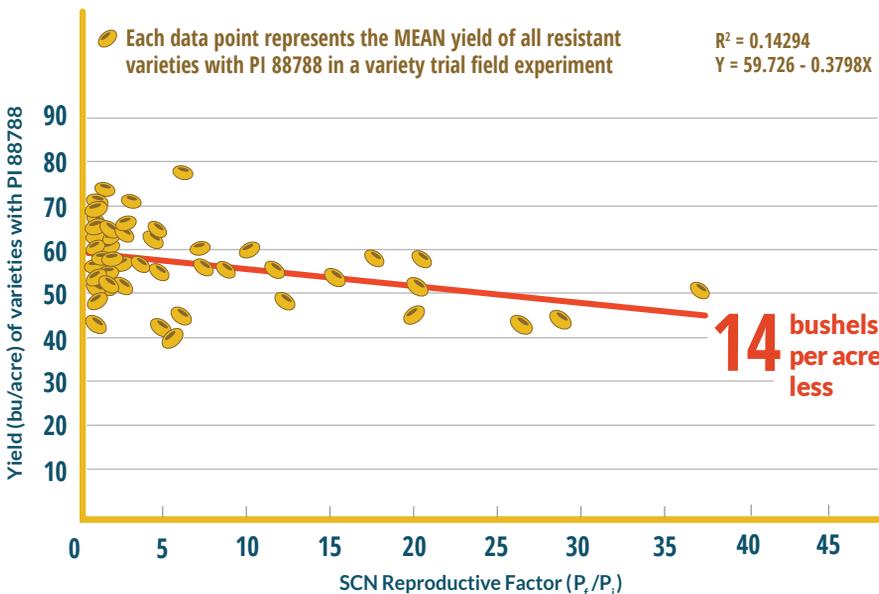
The percentage of SCN populations in a state/province with elevated reproduction (>10%) on PI 88788

## Nematodes are becoming “resistant to the resistance.”

A resistant variety should allow less than 10 percent reproduction. In other words, a resistant variety should stop 90 percent of the SCN in a field from reproducing. Across the region, varieties with PI 88788 resistance aren't hitting the mark. On some farms, one out of every two nematodes can reproduce.



## AS SCN REPRODUCTION INCREASES, yields decrease by as much as 14 bushels per acre.



Research shows yield loss as SCN populations increase on varieties with the PI 88788 resistance source. This data is from 25 years of variety trial experiments in farmers' fields in Iowa.

*The Reproductive Factor (RF) is the end-of-season number of SCN eggs divided by the beginning-season number of eggs. An RF of 2 means SCN egg numbers doubled from spring to fall. An RF of 4 means egg numbers quadrupled. The last data point on the far right in the graph has an RF of almost 40 (a fortyfold increase).*

Visit [TheSCNcoalition.com](http://TheSCNcoalition.com) for more information.



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# Expand Management to Minimize Yield Loss from Soybean Cyst Nematode

Variety selection important for SCN management

## As nematodes adapt, rotate resistant varieties

Growers have effectively managed soybean cyst nematode (SCN) for years by planting soybean varieties with SCN resistance. In fact, SCN-resistant varieties can help improve yields by more than 50 percent in heavily infested fields.<sup>1</sup>

Growers should focus on preserving the effectiveness of SCN-resistant varieties by rotating genetic sources:

- PI88788, the most widely used source, helps protect soybeans from two SCN races, including the most common Race 3
- PI548402, also known as Peking, provides resistance to three SCN races
- PI437654, also known as Hartwig, is available in a limited number of varieties

The PI88788 source no longer provides effective control in many fields. This causes a significant threat that requires grower attention and proactive management.

## Follow these SCN management practices

### 1. Test your fields.

Collect soil samples when soybean plants are mature to understand SCN populations in each of your fields.

### 2. Plant SCN-resistant varieties.

Work with your local Pioneer sales representative to identify the best Pioneer® brand soybeans with SCN resistance. Pioneer offers nearly 200 varieties with PI88788 resistance and more varieties with Peking resistance than any other seed company — all with outstanding yield potential, strong agronomics and the herbicide-tolerant (HT) traits you need.

### 3. Protect your seed investment with a seed treatment.

ILeVO® fungicide seed treatment has activity against SCN.

### 4. Scout regularly.

In late June or early July, examine soybean roots for SCN females.

### 5. Rotate to nonhost crops such as corn or alfalfa.

Effectiveness of crop rotation drops in subsequent years so managing SCN when egg numbers are low is important.

### 6. Rotate SCN-resistant sources.

Change sources of SCN resistance from one soybean crop to the next to help prevent nematode populations from adapting to SCN-resistant sources.

## Pioneer leads in SCN-resistant breeding

Pioneer is the industry leader in harnessing marker-assisted selection (MAS) to rapidly identify genes for SCN resistance and combine them with other high-value traits. Using proprietary MAS technology and precision phenotyping, Pioneer soybean researchers are stacking superior agronomic traits into new SCN-resistant varieties, providing even more choices in high yield potential Pioneer brand soybeans.

Ask your local Pioneer sales representative about additional SCN management recommendations and the Pioneer brand SCN-resistant soybean varieties best suited to your operation.

<sup>1</sup>Butzen S, Stephens P, Corbin T. *Rotating Sources of SCN Resistance*. Crop Insights. <https://www.pioneer.com/home/site/us/agronomy/library/rotating-sources-scn-resistance/>. Accessed Nov. 1, 2018.

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# Active SCN management needed

*As soybean cyst nematodes continue to resist SCN-resistant varieties, proactive management will save yields*

By CSD staff

**Similar to weed control, the easy button for managing SCN is losing its super power.**

SCN-resistant varieties are losing effectiveness as more nematodes are fighting through the genetic soybean resistance, due to reliance of varieties with PI 88788 source of resistance. And SCN infection can also increase soil-borne diseases such as brown stem rot, SDS and Fusarium root rot.

So, rather than continue to lose valuable soybean yield to the often-overlooked number-one yield robbing pest, let's examine different strategies to actively save yield and manage these wily nematodes.

## Soil test for SCN

First, and the most important rallying cry of the SCN Coalition experts, is “know your number” by soil sampling before every second or third soybean crop to determine and monitor changing SCN severity. Sampling for SCN is not a perfect science, as results are variable, but there are methods to improve accuracy. See page 22 story for details on soil sampling and scouting.

## Cultural practices

It's true you can reduce SCN numbers by rotating to non-host crops like corn, small grains, alfalfa, sugar beets, tomatoes and potatoes. But growers really need a multi-pronged strategy beyond crop rotation and resistant varieties.

Once SCN numbers by field are known, you can avoid moving

SCN-infested soil from field to field by cleaning machinery tires and tillage equipment before changing fields. Also watch winter annual weeds like henbit and purple deadnettle that serve as hosts because they can jump-start SCN cycles before winter and in spring. Soil pH can be a concern, as 7.4 and above can drive population densities higher, which lead to higher yield loss from SCN.

## Rotate resistant varieties

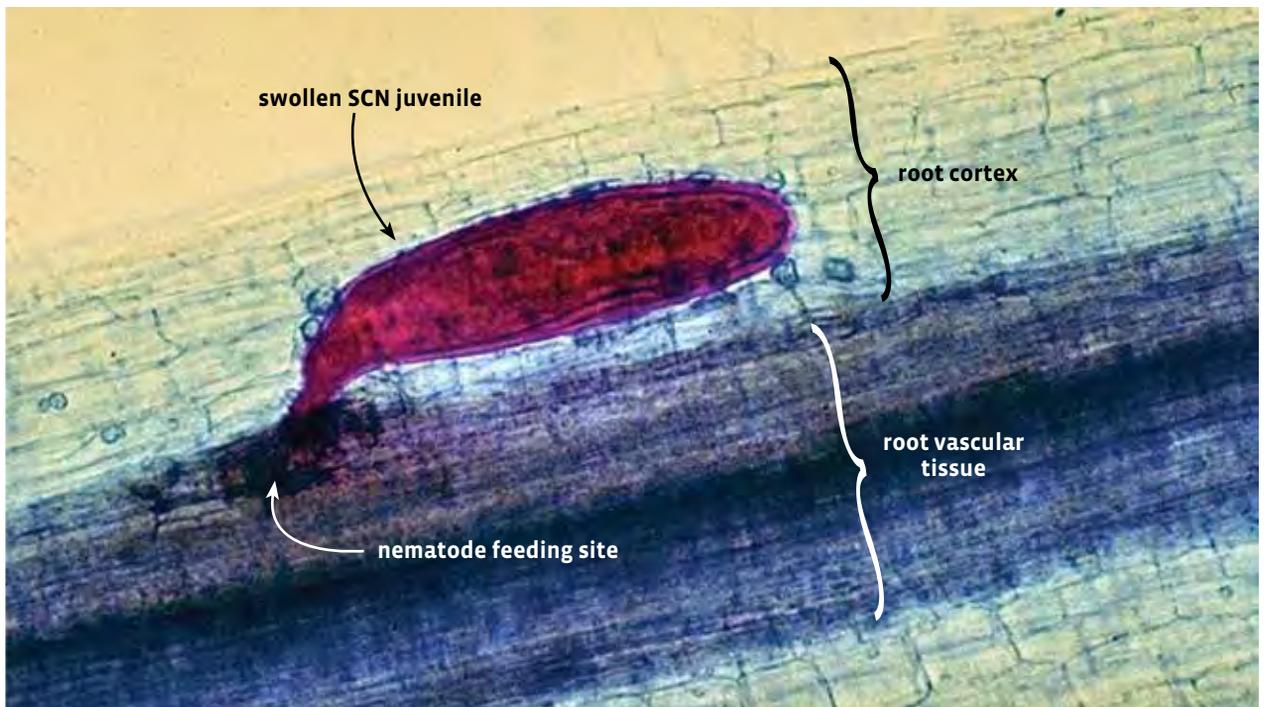
Another active management strategy is to rotate SCN-resistant soybean varieties with the PI 88788 source, because resistance levels can vary greatly. With Midwest and Ontario researchers finding that 20% to 50% or more of nematodes are now reproducing on PI 88788 resistant varieties, adopting this strategy stops repeated use of identical genetic resistance.

The challenge becomes understanding seed catalog and university ratings between seed sources. “Talk to knowledgeable seed company reps who understand their varieties,” says Mike Staton, Michigan State Extension educator. “The 2018 Michigan Soybean Performance Report is now a more valuable source as it lists the SCN source of resistance and designations like resistant, moderate, or susceptible to SCN for each variety.”

For example, Pioneer offers more than 200 varieties with PI 88788 source of resistance. “We encourage growers to rotate varieties with this resistance,” says Pat Arthur, soybean category leader for the company. “All varieties have been characterized with precision phenotyping, so when we commercialize varieties we know how it scores on



SCN soil sampling before every second or third soybean crop will help determine and monitor changing SCN severity.



When a juvenile nematode enters the root of a resistant soybean, the feeding site won't form properly, so the nematode dies in a few days. Unfortunately, more juveniles have now overcome the genetic resistance and are thriving in roots with PI 88788 source of resistance.

our 1 to 9 scale against different SCN races (HG types)."

### Rotate resistant sources

To continue an active management strategy, add a rotation to Peking type SCN-resistant varieties or other sources where available. Iowa State nematologist Greg Tylka describes this approach as integrated pest management.

"I advise farmers to use as many of these control options that make sense to control SCN. It's not just growing PI 88788 resistant soybeans, but it's also rotating crops, using seed treatments, and trying some Peking source (PI 548402) of resistance," he says. "The more tools a farmer uses in rotation to control SCN, or any pest, the less likely any individual management tactic is going to suffer decreased performance."

Case in point, Mike Staton knows a really good Michigan farmer who

was battling declining soybean yields in his muck soils without success. "He decided to conduct an HG type soil test and learned that his soybean cyst nematodes were reproducing at a high rate on his PI 88788 SCN-resistant soybean varieties. So, he shifted to a Peking resistant variety and saw huge and instantaneous yield increases, proving that rotating resistance sources can work," he says.

These results may run counter to certain beliefs that maintain there's still yield drag with Peking source SCN-resistant varieties. And as every farmer will tell you, yield is king.

The misperception that the Peking trait causes yield drag is simply not true for us, says Pioneer's Arthur. "Of the 17 varieties we offer today with a Peking source of resistance, 10 are new A-Series soybeans — the highest yielding class we've ever introduced," he says. "So far this year, with yield data still coming in,

our Peking varieties are performing very well, showing a 3 bushel per acre increase over competitive varieties across 94 trials."

It really comes down to the right product on the right acre. "That's why we are big supporters of the SCN Coalition, because they are promoting "know your number" and "take the test to beat the pest." Without doing this, it's difficult to align the right variety on the right acre," Arthur says. "Growers need to understand what's in the soil."

John Wilson, University of Nebraska Extension educator from Tekamah, believes that growers should rotate to a Peking source variety every other soybean year. "Even though 47% of Nebraska SCN testing samples show the nematodes are reproducing on PI 88788 source resistance, we could easily be up in the 90% range like the states east of us," he says. "If only someone could add a gene that would turn soybeans neon pink when under attack by SCN, then growers would realize it is present and reducing yields on perfectly healthy-looking soybeans."

## Nematode-protectant Seed Treatments

	Crop(s)	Targeted nematodes	Active ingredient	Mode of action
<b>Avicta Complete</b> Syngenta	cotton, corn, soybean	all plant-parasitic nematodes	abamectin	inhibits nematode nerve transmission
<b>N-Hibit</b> Plant Health Care, Inc.	all plants	all plant-parasitic nematodes	harpin protein	induced plant defenses
<b>Votivo</b> BASF	cotton, corn, soybean	all plant-parasitic nematodes	<i>Bacillus firmus</i>	living barrier of protection on roots
<b>Clariva pn</b> Syngenta	soybean	SCN	<i>Pasteuria nishizawae</i>	nematode parasite
<b>ILeVO</b> BASF	soybean	SCN, root-knot, reniform, lesion	fluopyram	SDHI enzyme inhibitor
<b>NemaStrike</b> Bayer Crop Science	cotton, corn, soybean	SCN, root-knot, reniform, lesion, others	tioxazafen	mitochondrial translation inhibitor
<b>AVEO</b> Valent	corn, soybean	SCN, root-knot, reniform, lesion, others	<i>Bacillus amyloliquefaciens</i>	not stated or known
<b>Nemasect</b> Beck's	corn, soybean	all plant-parasitic nematodes	heat-killed <i>Burkholderia rinojenses</i> + fermentation media	not stated or known

Nematode-protectant seed treatments offer numerous modes of action against SCN, giving growers another tool for active management.

Regarding the development of new genetic sources of resistance, it's not a profitable business model because there's no price premium for SCN-resistant varieties. That said, these SCN-resistant varieties have been a great, free source of protecting against SCN, until overuse started giving nematodes the upper hand.

### Nematode-protectant seed treatments

With soybean cyst nematodes becoming better at adapting to genetic resistance, the introduction of nematode-protectant seed treatments a decade ago was a much-needed new SCN management option.

Syngenta launched the first seed-applied nematicide called Avicta

over 10 years ago, then introduced a second-generation product five years ago called Clariva pn, for season-long protection against SCN in soybeans.

"As we introduced Clariva pn, we also encouraged the use of non-host crop rotation, genetic seed resistance and rotating genetic SCN resistance sources," says Dale Ireland, technical product lead on corn and soybean seed treatments for Syngenta. "Today, our premix formulation, Clariva Elite Beans seed treatment, is a sharp tool in the toolbox for season-long active management of SCN."

Saltro, a new product coming from the Syngenta pipeline in late 2019, is the company's third-generation nematicidal solution and latest

entry into SDS protection. "Saltro will offer very good activity on both SCN and SDS to provide an extra 3 bushels/acre over the leading competitive product, without any phytotoxic concerns," Ireland says.

Bayer will be launching its novel new synthetic mode-of-action seed treatment called NemaStrike for the 2019 season. "Based on multiple years of research and on-farm trials, NemaStrike shows control of SCN and other nematodes as they contact the roots, providing 75 days of important early-season protection," says AJ Hohmann, marketing manager for Acceleron and NemaStrike for Bayer.

He says that by stopping root feeding of a wide array of nematodes, less root piercing reduces the chance for subsequent diseases like brown stem rot and SDS to infect plants. "In four years of widespread trials across diverse environments and

geographies, we've seen a 2.2 bu/acre advantage versus the competitive nematicide standard," he says.

Hohmann encourages growers to try NemaStrike on their own fields to determine its advantages. "While growers testing their soil for SCN is great, we believe that since numbers can vary so much within a field, along with the potential to miss SCN pockets, that use of seed treatment across a field will ensure that nematodes are kept in check."

With annual losses of 120 million bushels to SCN—or up to 14 bu/acre lost due to SCN resisting the resistant varieties—growers need to take a more active role to control SCN, he says. "We believe seed treatments can play a vital role in controlling SCN populations across all acres."

BASF now takes the reins of ILeVO seed treatment, purchased from Bayer as part of their divestiture for buying Monsanto. It is also offered by Pioneer in their seed treatment package.

"We're a firm believer in active, integrated SCN management that begins with active soil sampling, then develop a plan to manage SCN through crop rotation, resistant varieties and seed treatments," says Jeremiah Mullock, product development manager for BASF.

"ILeVO has been on the market for a few years and has become a standard seed treatment for SDS protection and an excellent nematicide against SCN. Research shows it delivers a 2 to 4 bu/acre yield increase when controlling SCN," he adds. "It controls a broad spectrum of nematodes, early season in the seed zone, stopping SCN."

He admits that seed treatments like ILeVO won't change end-of-season SCN populations, so it's important to pair them with SCN-resistant varieties.

Mullock believes that by working with the SCN Coalition, increased education can help overcome common myths with SCN. Using

SCN-resistant varieties controls my SCN—research shows less effectiveness. Another myth, that rotating to corn will eliminate SCN, isn't factual, as it only helps reduce the egg populations, not eliminate them. And the same goes for the myth that if you don't see above ground symptoms, you won't lose yield to SCN. Truth is, yields will continue to decrease without testing, knowing your numbers and implementing active management.

University research on nematode-protectant seed treatments may not always mimic field-scale environments or results, but collaborations are productive for everyone.

Tylka and other researchers refer to the category as nematode-protectant seed treatments because not all of them are nematicides that kill nematodes outright. "The cool thing about them is that each one has a different active ingredient and a different mode of action. Some paralyze the nematode, some parasitize the nematode, some repel the nematode from the root, and some ramp up natural plant defenses," Tylka says.

University of Illinois research shows that nematicides work under proper environmental conditions. Rainfall, soil pH, soil microbial activity and moisture can reduce or increase their efficacy. Some nematicide seed treatments that degrade after a month or two can allow remaining nematodes in the soil to impact the root system and reproduce. In general, nematicides won't eliminate the SCN population or suppress the SCN population below economic thresholds.

"The challenge now, in a time of really low commodity prices, is that farmers may consider seed treatments a luxury," says Kaitlyn Bissonnette, University of Missouri plant pathologist. "But, seed treatments might not be a luxury if the mainstay of management, namely PI 88788 resistant varieties, is losing its effectiveness."

## Like most farmers

Paying attention to SCN wasn't, and still isn't, at the top of the soybean production problem list for Alex Recker, especially when weed resistance is very visible.

Recker, who farms near Arlington, Iowa, says his father Mike first learned about the invisible yield challenges of SCN in soybeans a decade ago when Iowa State researcher Greg Gebhart started doing SCN-resistant varietal trials on his farm.

"Luckily our problem never got bad enough, because with Greg's soil tests and the SCN-resistant variety results we saw every year, we were able to rotate crops and rotate varieties to keep the numbers down," Recker says. "We rely a lot on his variety trials to place the right SCN-resistant variety in the right fields that are showing higher SCN soil test numbers—and that has helped us head off SCN at the pass."

It's a silent yield robber, he adds. "Yes, we are concerned about resistance to SCN-resistant varieties—it reminds us of Roundup resistance." He is hopeful and excited about the new NemaStrike technology and how it can help overcome resistance to the resistance.

So, like most farmers, they don't pay much attention to SCN. But they have a researcher who supplies testing and varietal knowledge.

Hopefully, the SCN Coalition can convince more farmers to pay attention to SCN.



Sanitation tactics, like cleaning soil off equipment and tires, help keep nematodes from traveling field to field.

### Cover crops and SCN

With the growing interest in cover crops to improve soil and water quality and reduce erosion, there has been limited peer-reviewed research to determine their impact on SCN.

Nematologists are careful not to imply that SCN will be controlled with cover crops, unlike cover crop studies on the sugar beet cyst nematode. And they are leery of unsubstantiated claims of SCN control and eradication by using cover crops.

Michigan State University nematologist George Bird says it is well known that crops like corn and wheat are not SCN hosts so cover crops from the grass family should be safe to use in soybean production systems. It's also known that many legumes are hosts for SCN so cover crops from this plant family should be avoided in SCN-infested yields.

Regarding the radish/mustard group, Bird says they are complex. Currently, there's no published research indicating that these cultivars are safe to use in SCN-infested

fields or reduce risk to SCN. This is different from what is known for the sugar beet cyst nematode.

In addition, some cover crop cultivars are being marketed for



While there's growing interest in cover crops to hopefully reduce SCN numbers, more scientific studies are needed to prove benefits.

general nematode management, so growers should seek evidence regarding the impact of the specific cultivar or blend of cover crops on SCN and other nematodes of interest. Bird notes that cover crop research with radishes and mustards is currently underway and additional information should be available in the near future.

Greg Tylka says that published reports of greenhouse experiments indicate alfalfa, Austrian winter pea, cowpea, clovers, and hairy vetch, plus Daikon-type and oilseed radish, do not support SCN reproduction. One exception is pennycress, often considered a winter annual weed, which might become a cover crop in Michigan, Minnesota, Ontario and other areas. "Pennycress should not be grown as a cover crop in SCN-infested fields because it is a moderately good host for SCN," he says.

Regarding the possibility of cover crops reducing SCN population densities in the field, there is very little published literature currently available. "There's been no published data on leguminous cover crops such as alfalfa, Austrian winter pea, cowpea, clovers, and hairy vetch."

A Illinois study published in 2017 found canola and rapeseed reduced SCN numbers more than any cover crop in one-third of 16 experiments and cereal rye reduced SCN in 3 of 12 field experiments; mustard had no effect on SCN numbers in 6 experiments.

Tylka indicates that work is ongoing at several Midwest and Ontario universities examining effects of annual rye, canola, mustards, radishes, rapeseed, and mixes or blends of these plants on SCN population densities in field studies.

In conclusion, Bird says the effects of cover crops on SCN might vary by plant variety or cultivar and among SCN populations and soil types. More research-based information is needed before cover crops can be widely recommended as a reliable means of managing SCN. ◀

# WHY YOU NEED TO TEST YOUR FIELDS TO KNOW YOUR NUMBERS.

**What's your number?**

Take the test.  Beat the pest.

The **SCN** Coalition™

Funded by the soybean checkoff

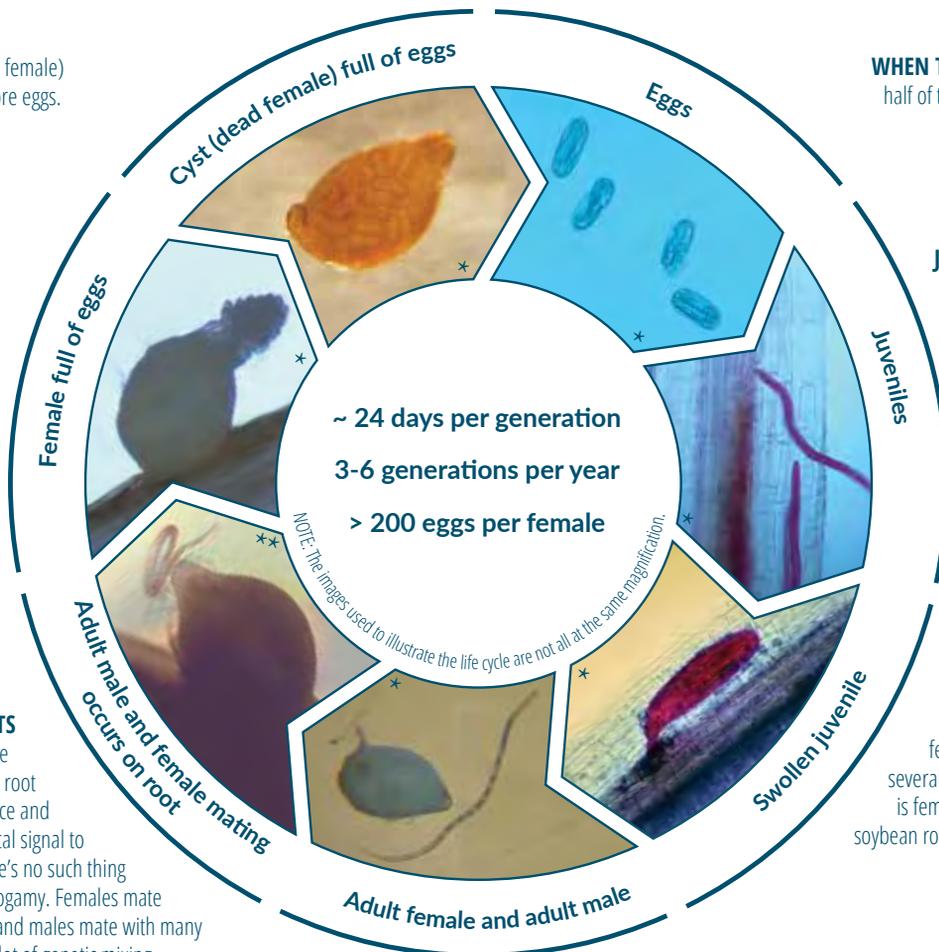
## THE SOYBEAN CYST NEMATODE life cycle.

The SCN life cycle can be completed in as few as 24 days during the growing season. There can be from three to six generations per year.

**EACH CYST** (dead female) contains 200 or more eggs.

**AFTER MATING**, she makes about 50 eggs outside her body and fills up with another 200+ internally. Then she dies and her body wall hardens to form the cyst.

**THE FEMALE GETS SO LARGE** that she ruptures out of the root onto the root surface and sends out a chemical signal to attract mates. There's no such thing as nematode monogamy. Females mate with many males, and males mate with many females. There's a lot of genetic mixing.



**WHEN THE CYST BREAKS**, half of the eggs will become male and half will become female.

**JUVENILE WORMS** hatch from eggs and burrow into soybean roots to feed and develop. There's no way to tell whether a juvenile is male or female at this stage.

**THIS JUVENILE IS SWOLLEN** from feeding in the root for several days. If this juvenile is female, she'll stay in the soybean root and keep feeding.

**IF THE JUVENILE IS MALE**, it will revert back to a worm shape and leave the root.

\* Tylka, Iowa State University  
\*\* Chitwood, USDA

Visit [TheSCNcoalition.com](http://TheSCNcoalition.com) for more information.

# INVISIBLE. INVASIVE. UNDER ESTIMATED.

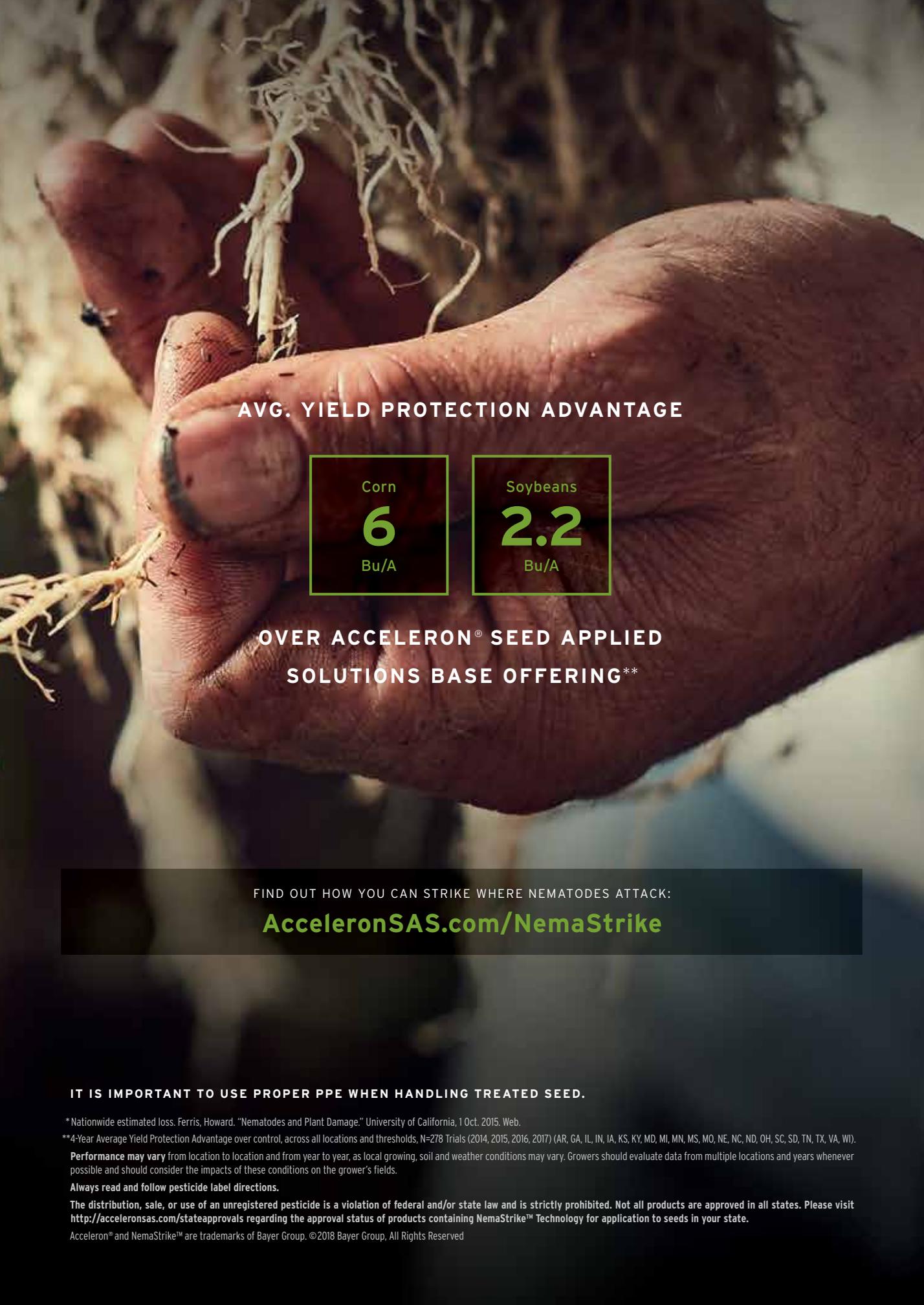


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Bu/A

Soybeans

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**IT IS IMPORTANT TO USE PROPER PPE WHEN HANDLING TREATED SEED.**

\* Nationwide estimated loss. Ferris, Howard. "Nematodes and Plant Damage." University of California, 1 Oct. 2015. Web.

\*\* 4-Year Average Yield Protection Advantage over control, across all locations and thresholds, N=278 Trials (2014, 2015, 2016, 2017) (AR, GA, IL, IN, IA, KS, KY, MD, MI, MN, MS, MO, NE, NC, ND, OH, SC, SD, TN, TX, VA, WI).

Performance may vary from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower's fields.

Always read and follow pesticide label directions.

The distribution, sale, or use of an unregistered pesticide is a violation of federal and/or state law and is strictly prohibited. Not all products are approved in all states. Please visit <http://acceleronsas.com/stateapprovals> regarding the approval status of products containing NemaStrike™ Technology for application to seeds in your state.

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# Test your soil

*Knowing your SCN egg counts by field over time provides valuable data if done correctly*

*By CSD staff*

## Get the real score on your

SCN management results by sampling fields. It's the only way to tell if your strategy is working.

Most soybean growers now face the reality of increasing SCN infestations, because research has proven that using resistant varieties provides less protection against the underground pest. Over the past two decades, SCN developed varying levels of reproduction on the the PI 88788 breeding line used in most current commercial soybean varieties. That means developing a management strategy now is key to maintaining yield, and it all starts with sampling.

## When to sample soil

While SCN sampling can be done at any time, fall works best for many farmers, following harvest. Sam Markell, North Dakota State University plant pathologist, and leader of the SCN Coalition, says SCN sampling can be done in conjunction with fall fertility sampling, making it a simple task to accomplish.

“With research showing that SCN populations are becoming resistant to the source of resistance (PI 88788) used in 95% of commercial soybean varieties, farmers can no longer assume that planting an SCN-resistant variety is controlling this pest,” Markell says. “That’s why

**Sampling both in corn (before soybeans the following year) and in soybeans provides data to determine best management strategies.**

the SCN Coalition recommends that farmers know their nematode numbers.”

Fall is a perfect time to sample fields where soybeans were grown this year, as well as fields planted to corn in 2018 and slated for soybeans next year. “You’ll get information on this year’s crop, as well as data to help you make management decisions next spring,” Markell says.

Albert Tenuta, plant pathologist, OMAFRA in Ontario, agrees that fall sampling works best on many farms but says the important thing is to get a handle on SCN population regardless of sampling time. “It can be done in spring if you wait until the ground thaws. Summer is okay, too. Core samples can be done almost any time,” he says.

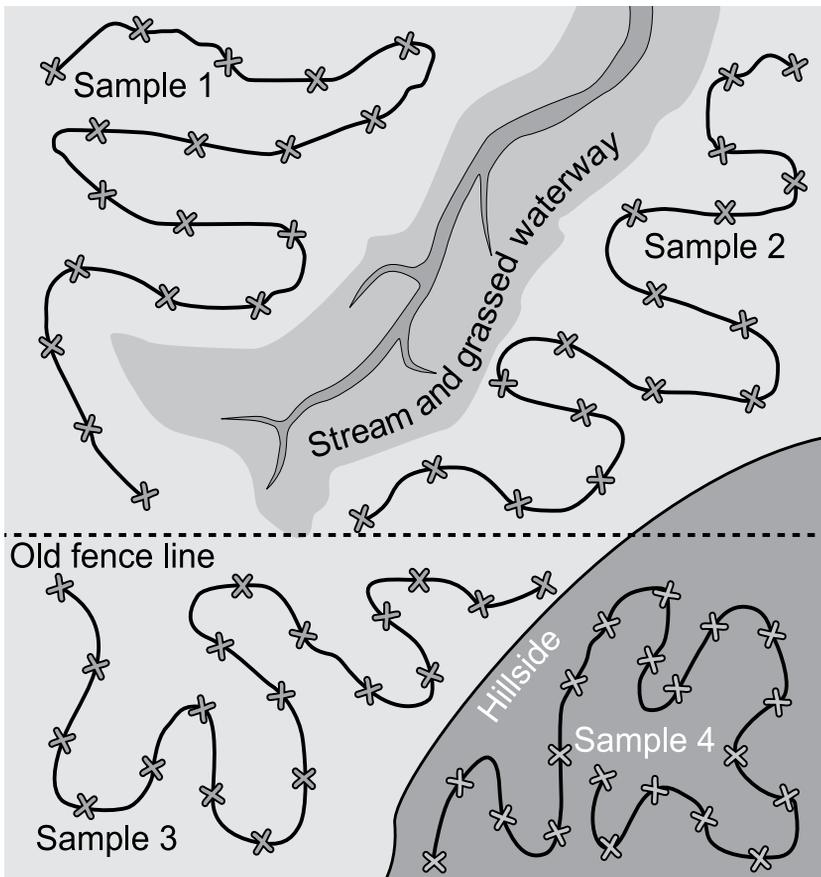
“What a farmer needs to do currently is, first, find out if he or she has SCN in the fields that they’re farming, and, then, secondly, get soil samples taken so they know their egg count, or population density,” Tenuta says.

The number, however, can vary a good deal within individual fields. Samples that indicate no SCN present may be correct, Tenuta says, or could be off-base depending on where and how they were collected (see testing infographic, page 25).

## How to sample a field

Gathering 15 to 20 soil cores from 6 to 8 inches deep within a 20-acre area will be more reliable. “What I tell folks is collecting 20 cores from four 40-acre parcels is better than





Many specialists recommend using a zig-zag pattern to dig cores within fields to get a representative sample of soil types and conditions. Gathering 15 to 20 cores within a 20-acre area will be reliable. Sampling four 40-acre parcels is better than two 80-acre parcels.

from two 80-acre parcels. So, the guiding premise is, the more cores you take from the smaller the area, the more accurate your results are going to be. You could miss it if you're only taking 20 cores from a giant area like 80 acres," Tenuta says.

Many specialists recommend using a zig-zag pattern to collect cores within fields to get a representative sampling of soil types and conditions. Sampling within the rows will make it easier to hit the higher SCN populations.

"We'd like cores collected either in a zig-zag pattern, or you can pull cores from high-risk areas in the field," Markell says. "Those include entry ways, high soil pH areas, low spots and areas that have previously flooded, as well as areas in the field

with unexpectedly low yields that you can't explain."

Soil sampling makes it possible to gather real data. Eyeballing fields for SCN infestation accomplishes little because soybean fields can have no visual symptoms but still sustain considerable yield loss. Soybeans in heavily-infested fields can appear green and normal.

Tenuta says visual estimates are tough. That's why he recommends soil sampling to understand what's happening in fields. "It establishes a base (benchmark SCN levels) for management," he says.

Some farmers, in fact, probably are not aware of how much yield they're losing to SCN, since they've assumed resistant varieties gave them protection against the pest.

"The effectiveness of the common source of resistance is eroding," Tenuta says. That makes sampling more important than ever.

"Sampling lets you know if SCN numbers are being managed, over time. Tracking the trend gives you an idea of whether varietal resistance is declining," says Angie Peltier, Minnesota Extension educator.

A bit of luck can be involved when using soil probes. The SCN Coalition notes that as little as a half-inch difference in probe placement can mean either finding no SCN eggs or many.

Just because a field test is low does not mean infestation will remain at that level. SCN moves easily from field to field via wind and water, implement tires, tillage equipment, even on people and animals, according to research by the North Central Soybean Research Program.

### Test to learn nematode types

Another procedure called an HG (for *Heterodera glycines*, the scientific name for SCN) test is used to determine if SCN from specific fields has developed resistance to the



Take 8-inch-deep soil cores for SCN.



Pulling soil cores in the soybean root zone helps achieve good egg counts.

resistance used in soybean breeding lines. If you think your varieties may be losing the fight against the SCN in your fields, this is a way to find out.

The HG test allows the SCN to grow out on soybeans in a greenhouse for 30 days. Many land-grant universities and private labs now offer HG tests (for a fee), in addition to traditional SCN soil egg count tests.

“If farmers have grown resistant soybeans in the past, it might be worth getting the HG type test to find out what that percent reproduction number is on their nematode on PI 88788,” says Kaitlyn Bissonnette, University of Missouri plant pathologist.

Soybean board checkoff dollars in several states offer free SCN soil testing, so it may cost little to nothing to test fields, so you know your numbers. The following states currently offer soybean farmers free SCN soil testing: Arkansas, Michigan, Minnesota, Nebraska, North Dakota, Ohio, South Dakota, Tennessee, Texas, Virginia, West Virginia and Wisconsin.

“This list isn’t exhaustive, so check with your state soybean board,” Markell says.

In states that don’t offer such assistance, SCN tests generally cost \$1 to \$2 an acre. “The yield loss potential is 10 to 20 bushels per acre, so testing makes economic sense,” Markell says. “You can have yield losses of up to 30% from SCN with no above-ground symptoms.”

### Watch testing standards

Testing can vary from one laboratory to the next. “Farmers need to be mindful that results often aren’t expressed in the same units, and the big lookout is the volume of soil. So, if I was told that an egg count from a field was 10,000, it would be important to know if that was 10,000 eggs per 100 CCs of soil, which is about a half a cup of soil, or if it was 10,000 eggs per 500 CCs of soil,” Bissonnette says.

“There are, in particular, private laboratories that will process different amounts of soil. If you have 10,000 eggs per 500 CCs of soil, that

is less worrisome than 10,000 eggs per 100 CCs of soil because it’s a smaller volume.”

Some labs save money by reporting the number of cysts per volume of soil rather than the number of eggs. That further complicates a process that already can be confusing, because the number of eggs in cysts varies greatly—from 20 to 200 or more.

### Egg count severity

Fred Warner, Michigan State University nematode diagnostician, says in SCN soil samples, zero eggs or juveniles detected means that area of the field has a low infestation. Fewer than 999 eggs or juveniles means the area sampled has a low infestation. From 1,000 to 9,999 eggs or juveniles means that field should be planted to a non-host crop for a year, followed by a SCN-resistant variety. If more than 10,000 eggs or juveniles are present in a sample, the field should get a non-host crop for two or more years, along with a SCN-resistant variety when soybeans get planted there next.

Rotating with non-host crops like corn, sorghum, sunflower and alfalfa can keep SCN numbers in check. But SCN can survive years without feeding on soybeans. All the eggs contained in the cysts formed by the adult females don’t hatch at once. Some become dormant in the soil and can remain that way for 10 years.

Farmers are never going to get rid of SCN once it’s in their field. But it’s not a death sentence. It’s something they can learn to manage as a chronic health problem for soybeans in that field.

Farmers should even sample fields after harvesting non-host crops, like corn, as part of their overall management approach.

That’s the kind of technique living with SCN now requires. Get used to it. Start by sampling. Know your number, as the SCN Coalition says. ◀

# SCOUTING AND SOIL TESTING FOR SOYBEAN CYST NEMATODE.

What's your number?

Take the test.  Beat the pest.

The **SCN** Coalition™

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## TWO WAYS to scout for SCN.

**1** Dig roots and look for females. (Dig, don't pull.)

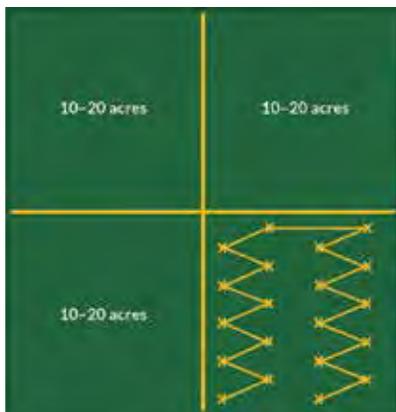


**2** Collect soil samples for testing.

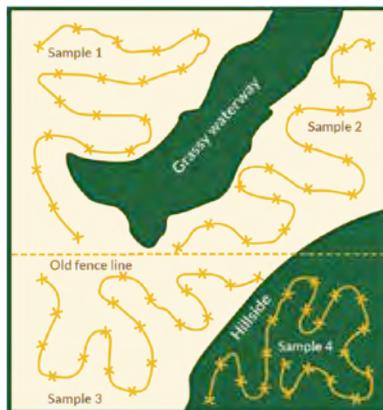


## THREE APPROACHES to collecting soil samples.

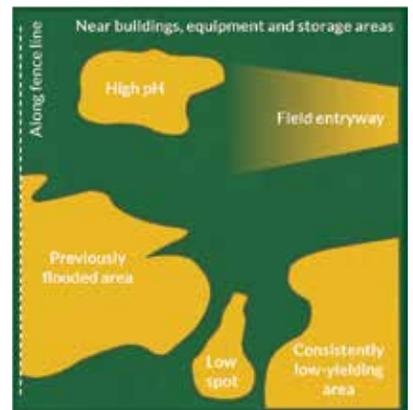
Collect 15–20 (or more) 1-inch-diameter cores, 8 inches deep, for every 20 acres. Mix the cores well, put the mixed soil into a soil sample bag and send it to an SCN testing lab.



**1** Collect soil cores using a zigzag pattern.



**2** Collect soil cores from logical areas or management zones in the field.



**3** Collect soil cores from high-risk areas in the field where SCN might first be discovered.

## WHEN to sample.

- Fall in a non-host crop.
- Fall in soybean stubble.
- Spring before a soybean crop.
- During the season in the soybean crop root zone.



Visit [TheSCNcoalition.com](http://TheSCNcoalition.com) for more information.



Send nematodes to that  
great soybean field in the sky.  
All season long.

Many seed treatments claim to be effective against soybean cyst nematodes (SCN), but next-generation Clariva® Elite Beans seed treatment is the only one proven to kill them throughout the growing season. By combining a tough nematicide with the unbeaten insect and disease protection of CruiserMaxx® Vibrance® Beans\* seed treatment, Clariva Elite Beans says R.I.P. to SCN. Contact your Syngenta representative or visit [SyngentaUS.com/CEB](http://SyngentaUS.com/CEB)

\*Refers to CruiserMaxx Vibrance alone or in combination with additional Apron XL®

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# SCN control tactics may vary

*Techniques and recommendations can vary by state and SCN history*



A single cyst nematode feeding on soybeans or weed hosts in optimal environmental conditions can result in several thousand nematodes being produced in one growing season. A life cycle can happen every four weeks, and optimal soil temperatures are 76 degrees F for root penetration, and 82 to 89 degrees F for juvenile and adult development.

*By CSD staff*

## Spending a little time looking

at the animated map of soybean cyst nematode spread can leave you with an eerie, queasy feeling. The nematode moves bit by bit across the country, in a stealthy manner not showing visible signs of yield loss.

First identified in New Hanover County, N.C. in 1954; by 1957 SCN arrived in a handful of counties

in southeast Missouri, eastern Arkansas, west Tennessee and northern Mississippi. In the 1970s it continued to spread. By 1980, it crept into most soybean-producing areas in the U.S. By 2014, SCN was just about everywhere soybeans are grown, including Ontario, and had also been identified in Puerto Rico and Hawaii. It's also in South America and has even been found in Italy.

## Active management needed

Dealing with SCN now requires a full and active management approach, most scientists agree, like that outlined on [TheSCNcoalition.com](http://TheSCNcoalition.com).

In Ohio, SCN was first spotted in 1987. Now it's in 68 Ohio counties. The Ohio State University plant pathology team says good management starts with knowing precisely the level of field infestation. They recommend sampling fields in the

fall after soybean harvest, noting that SCN population can increase twenty- to thirtyfold in a single growing season. Sample early and the number may appear lower than it actually is. In sampling it's important to remember that SCN is not distributed evenly throughout a field, they say.

### Watch specific field areas

North Dakota State University specialists give their farmers some extra sampling tips. Sample field entrances because that's where SCN comes in on machinery. Probe flood-prone areas and low spots, since cysts move with water. SCN can also be transported by birds, which frequent wet spots. Sample consistently low-yielding spots, since they could result from SCN invisible to the naked eye. Sample near fence lines and shelter belts because wind can carry SCN to those places. Test field areas that have yellow spots in August, since that's when heavy SCN damage makes a visual appearance. Check high pH soils because SCN thrives in them.

If your soil test cyst/egg count is low, SCN-resistant varieties alone can protect the soybean crop, says Jason Bond, Southern Illinois University nematologist. He says if the count is moderate to high and you've already been growing SCN-resistant varieties, you need to determine your SCN type, requiring an HG type test to help select resistant varieties that will work best in your field.

### SCN HG types

Bond says there are four basic SCN types. Of those, Type 2 is a big concern because it attacks PI 88788 resistance, which is present in most current commercial soybean lines. If your fields have Type 2 SCN, you should switch to varieties with a different base of resistance. Bond notes that Type 1 SCN attacks the Peking source of resistance, which is present in a few commercial varieties. If you

have that, don't plant varieties with Peking resistance. Type 3 SCN does not occur in Illinois, Bond notes. Type 0 does not attack any SCN resistant soybean varieties. Type 4 attacks only SCN-resistant soybeans with PI 437654 type of resistance, also known as Hartwig or CystX. If that's the problem in your field, avoid those varieties and rotate with a non-host crop such as corn for two or more years before again planting soybeans.

In fact, anytime you have a high SCN egg count and have been growing resistant varieties, you should plant a non-host crop. When SCN infestation is heavy, rotating just one year to corn may not stem the problem, either.

"Multi-year crop rotations with non-host crops and management of weed hosts are important measures to take in attempts to reduce SCN populations. In most cases, a short corn-soybean rotation is not long enough to effectively reduce SCN populations in soybean fields," says Nathan Schroeder, University of Illinois nematologist.

Because of SCN's 30-day life-cycle, a single cyst nematode juvenile

feeding on soybeans or weed hosts in optimal environmental conditions can result in several thousand cysts in one growing season, Schroeder says. Fail to stop that population boom and the field is in deep trouble for growing soybeans again.

### Dig up roots

"While observation of white females will confirm an SCN infestation, it tells you little about the level of infestation. If you dig up roots and don't find a white female, that doesn't mean SCN is absent. The only way to get a reliable diagnosis is through a professional diagnostic laboratory," says Shawn Conley, University of Wisconsin agronomist.

If you're curious and want to investigate, though, look carefully. "Care should be taken to gently dig out the plant without damaging the roots. Pulling the plant from the soil will leave most of the feeder roots in the soil and can dislodge the cysts from the remaining roots," says Emmanuel Byamukama, South Dakota Extension plant pathologist.

Like nematode specialists throughout the Midwest, Byamukama recommends crop

#### Example of SCN egg count categories

##### If soybeans are the next crop to be grown

Low	= 1–2,000 eggs per 100 cc soil
Medium	= 2,001–12,000 eggs per 100 cc soil
High	= >12,000 eggs per 100 cc soil

##### If soybeans are NOT the next crop to be grown

Low	= 1–4,000 eggs per 100 cc soil
Medium	= 4,001–16,000 eggs per 100 cc soil
High	= >16,000 eggs per 100 cc soil

If your soil test cyst/egg count is medium to high and you've already been growing SCN-resistant varieties, you need to determine your SCN HG type, requiring an HG type test to help select resistant varieties that will work best in your field. Check your state university for categories of SCN egg count severity.



While digging roots to check for white females can confirm an SCN infestation, it tells you little about the level of infestation. If you dig up roots and don't find a white female, that doesn't mean SCN is absent.

rotation to slow SCN. Farmers in the Dakotas have additional rotation options, however, including sunflowers, flax, canola and alfalfa.

In Indiana, Jamal Faghihi, Extension entomologist, estimates that SCN now infests 45% of the state's soybean fields. He recommends building a management plan around crop rotation and resistant varieties. Farmers should do an HG Type test every 10 years to determine the best source of SCN resistance in their fields.

Examine higher risk field areas for SCN: field entrances because that's where SCN comes in on machinery; flood-prone areas and low spots, since cysts move with water; consistently low-yielding spots, since they could result from SCN invisible to the naked eye; fence lines and shelter belts because wind can carry SCN to those places; yellow spots in August, since that's when heavy SCN damage makes a visual appearance; and high pH soils because SCN thrives in them.

“Soybean cultivars with Peking or PI 437654 (Hartwig, CystX) source of resistance should be used if your SCN population can overcome the PI 88788 resistance,” Faghihi says.

In Minnesota, SCN was first confirmed in 1978 in Faribault County, in the southern portion of the state. By 2000, it was in most of the state's

soybean counties, and by 2009, conquered the rest of them.

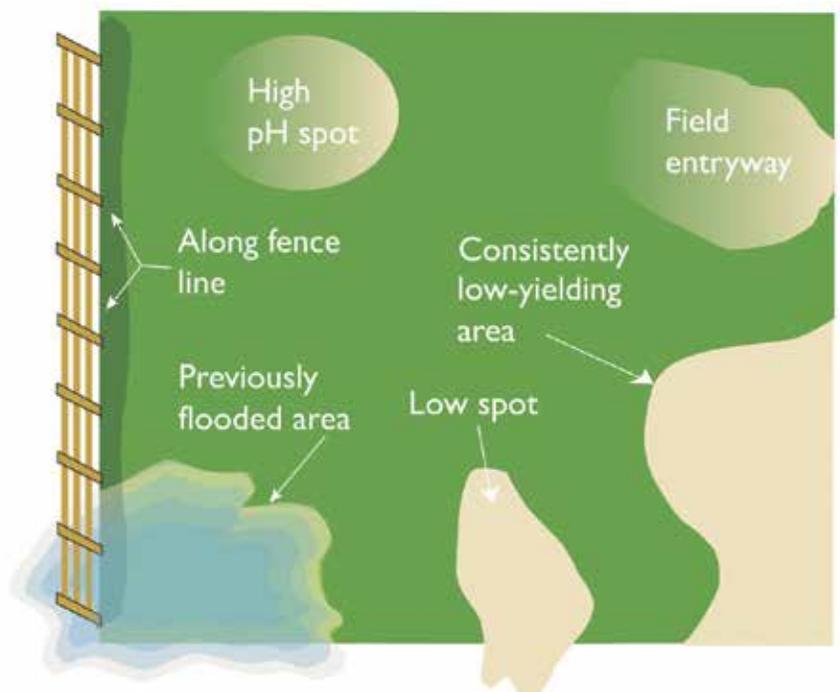
“Cysts on roots can contain hundreds of eggs that are eventually released into the soil and can remain viable for years until a suitable host plant is found. Host range includes soybean and numerous legume and weed species,” says Dean Malvick, Minnesota Extension pathologist.

The presence of soybeans and legume weeds is more important to SCN's spread than hot or cold temperatures. Some environmental conditions do favor its development, however.

### Impact of temperature

“Moisture and fertility stress can enhance the disease. High soil pH can favor SCN. Planting continuous susceptible soybeans favors SCN,” Malvick says.

The length of the SCN life cycle is typically about four weeks depending on geographic location, soil temperature, and nutritional conditions. Optimal soil temperatures are 76 degrees F (25 C) for root penetration, and 82 to 89 degrees F (28–32 C) for juvenile



and adult development. Little or no development takes place either below 59 degrees F (15 C) or above 95 degrees F (35 C).

“In southern Minnesota, SCN can complete three to four generations during a soybean growing season. In central to northern Minnesota, the nematode probably completes only three generations,” says Malvick. That means cold weather may slow SCN a bit but certainly won’t stop it. In fact, nothing really stops it except encountering no soybeans to infect.

SCN moved westward just as it headed to northern states. In Nebraska, it first appeared in Richardson County in the southeastern part of the state in 1986, says John Wilson, Extension educator. Now it is found in 59 counties in the eastern half of the state.

“These counties produce over 93% of Nebraska’s soybeans,” Wilson says. “In 1986, only a few soybean varieties were resistant to SCN. By 2000 there were hundreds of SCN-resistant varieties. Today, most varieties have some genetic resistance to SCN.”

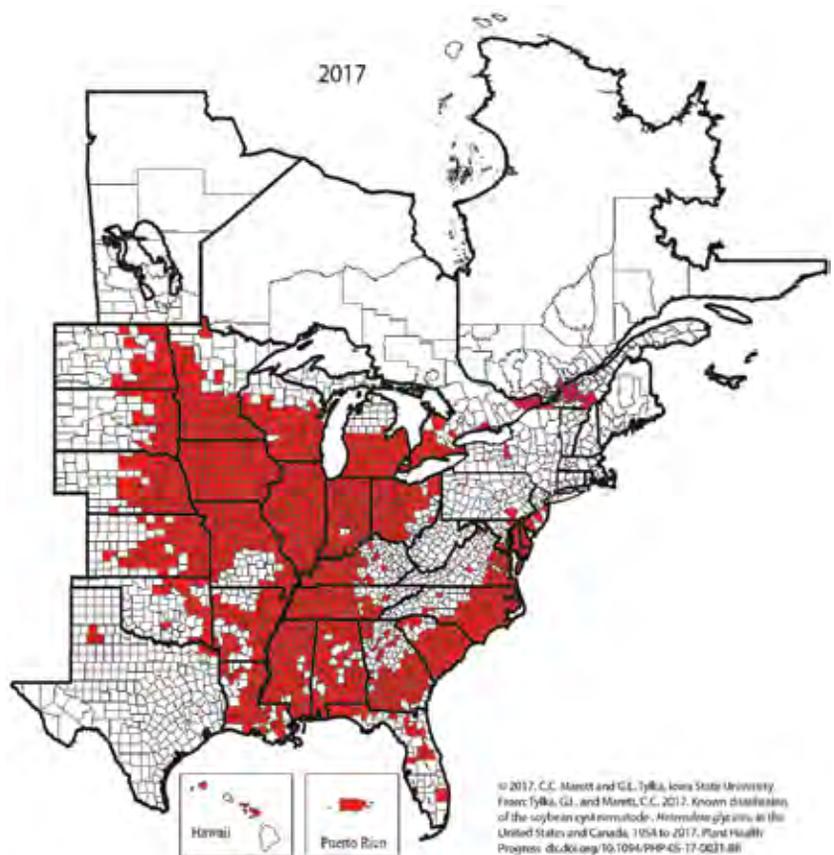
After being spotted in Richland County, N.D. in 2003, SCN spread into a dozen counties in that state over the next decade.

Sam Markell, North Dakota State Extension plant pathologist, says SCN is rapidly expanding into areas of newer soybean production and farmers in that state should build a management plan with the best tools available. “In some maturity groups, we have many varieties without genetic resistance, yet we have many crop rotation and seed treatments options,” Markell says.

### Resisting the resistance

Despite that varietal resistance, SCN marches on, overcoming the best defense humans throw in front of it.

SCN showed up in Iowa in 1978 in the north-central part of the state. It spread in a random pattern,



First identified in North Carolina soybeans, SCN spread east and north during the 1970s and by 1980 it was found in most soybean-producing areas in the U.S. With 95% of all SCN-resistant soybean varieties containing the same source of resistance (PI 88788), overuse of these varieties for 20-plus years has caused SCN to become resistant to the resistance.

year-by-year, until it now exists in every Iowa county.

“It can take five to nine years from SCN introduction into a field until populations are detectable,” says Iowa State University nematologist Greg Tylka.

SCN’s pattern of rapid growth remains the story wherever soybeans grow. SCN appeared in Kansas in 1985 and quickly moved throughout the eastern half of the state. South Dakota’s experience pretty much mirrors that of other states. SCN arrived there in 1995 in Union County, in the extreme southeastern corner of the state. Now it’s across the eastern third of the state.

Farmers have to develop a

management strategy to live with it and still make decent soybean yields, says Byamukama.

“A well-managed soybean crop will yield higher and can withstand low levels of SCN infection. Maintain optimum fertility, control weeds (weeds such as pennycress and henbit are hosts of SCN), and ensure proper drainage,” he says.

To do that, you’ll have to know your numbers, the level of SCN infestation in fields, and develop a plan to maintain productivity in coming seasons. Easy? No. But doable? Yes.

For more details and in-depth information by state/province, check out the SCN Coalition website, [theSCNcoalition.com](http://theSCNcoalition.com). ◀

# SCN reproduction puts rabbits to shame.

A new generation of SCN is born every 24 days during summer. Even with an attrition rate of 99% (meaning 1 percent of eggs survive each generation) one cyst can become 48,828 eggs in four generations.

What's worse, SCN is spreading, adapting and reproducing on SCN-resistant soybean varieties — **and yields are decreasing.**

Have you tested your fields lately? Head to [TheSCNcoalition.com](http://TheSCNcoalition.com) for soil sampling tips, testing labs and state-specific SCN management advice.

200 eggs  
from 1 cyst

25,000 eggs  
after 1 generation

31,250 eggs  
after 2 generations

39,062 eggs  
after 3 generations

48,828 eggs  
after 4 generations

**What's your number?**

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