Soybean Cyst Nematode

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Soybean cyst nematode (SCN), *Heterodera glycines*, was first identified in Ohio in 1981 and has now been found on soybean in 72 of 88 of Ohio counties. SCN damages soybeans by feeding on roots, robbing the plants of nutrients, and providing wound sites for root rotting fungi to enter. The severity of symptoms and yield losses are dependent on several factors including: the number of nematodes present in the field at planting, the soybean variety, tillage practices, soil texture, fertility, pH, and environmental conditions during the growing season. Once SCN is established in a field, it rarely is eradicated. SCN is the leading cause of soybean yield loss in North America and now occurs in all major soybean production areas worldwide.

Symptoms and Signs

Symptoms are highly variable. Symptom development depends on several factors, especially population densities of the nematode, the presence of other pathogens, soil nutrient status, resistant soybean varieties planted previously, and rainfall. Often, yield is reduced when there are no visible symptoms. SCN injury can also easily be confused with other crop production problems such as nutrient deficiencies, injury from herbicides, soil compaction, or other diseases. Moderate symptoms include circular to oval patches of yellowed plants with reduced yield (Figure 1). Affected areas may increase in size each year, usually in the direction of tillage. Severe symptoms include patches of very stunted plants and lower yields.

SCN females may be found along the sides of soybean roots during the summer months. The female body swells with eggs and initially appears as a small, white pearl or “lemon” on the root (Figure 2). Once the female matures, the outside becomes brown, hard, and more difficult to see. Roots must be gently dug from the ground, the soil gently shaken or washed off, and examined closely for the presence of bright white to yellow females. Nodules, where symbiotic nitrogen fixation occurs, are also on the roots of soybean plants but are irregular in shape and much larger than cysts.

Figure 1. *Severe symptoms of soybean cyst nematode can be seen with chlorotic and necrotic plant symptoms. These symptoms, however, are non-diagnostic, thus soil sampling needs to be done for proper diagnosis.*

SCN Life Cycle

In the early life stages, SCN is a microscopic (1/64 inch long) roundworm that feeds on soybean roots. There are three major life stages of cyst nematodes: egg, juvenile, and adult. In Ohio, the life cycle can be completed in 24 to 30 days under favorable conditions. It is possible to have three to five generations (complete life cycles) each growing season.

The juveniles hatch from eggs and search for soybean roots. However, since the juveniles can move only a short distance through the soil before entering the root, they starve to death if no root is found. Water movement throughout the field may also aid in moving SCN juveniles. After penetrating the root, the nematode feeds on cells in the vascular tissue. It secretes digestive enzymes that stimulate the development of enlarged cells (called syncytia) that the nematode uses as its feeding site.

The cyst stage is the body of the dead female nematode filled with eggs (Figure 4). This cyst is highly resistant to adverse conditions and serves to protect the developing eggs and juvenile nematodes for many years. A cyst may contain as many as 250 eggs, depending on how old it is and how healthy the female was when feeding on its host

Figure 2. Cysts, or mature females, can be seen as small, bright white dots on the outside of the roots.

(Figure 4). Before the female dies, she deposits some of the eggs outside of her body in a jelly-like mass. These eggs begin to hatch in a few days and may continue to hatch for the next several months to a year. Many eggs remain protected in the cyst and may hatch years later, while those on the outside die during the winter. Generally, 50% of the eggs produced by a female hatch each year, thus the population may drop significantly after several years if there are no susceptible host plants present.

Management

Step 1: Identify the fields that have cysts and monitor egg populations. SCN populations are highest in the fall after soybeans are harvested. SCN populations can increase as much as 10 to 40 times in a single growing season. More importantly, SCN is not distributed evenly throughout a field (Figure 3).

The number of SCN cysts or eggs found in the soil sample will determine the best management plan for the field (Table 2). Techniques for sampling soil for SCN by the Soybean Cyst Nematode Coalition are as follows:

- Use a one-inch diameter soil probe to collect samples (6 to 8 inches in depth).
- Follow a zigzag pattern; collect 10 to 20 soil cores per 10 to 20 acres.
- Collect cores from areas of similar soil types and crop history.
- Dump cores from each 10 to 20 acre area into a bucket or tub and mix thoroughly.
- Place 1 pint (2 cups) of mixed soil in a soil sample bag or plastic zippered bag and label with a permanent marker.
- Store sample in a cool, dark place until shipped to a SCN analysis lab.

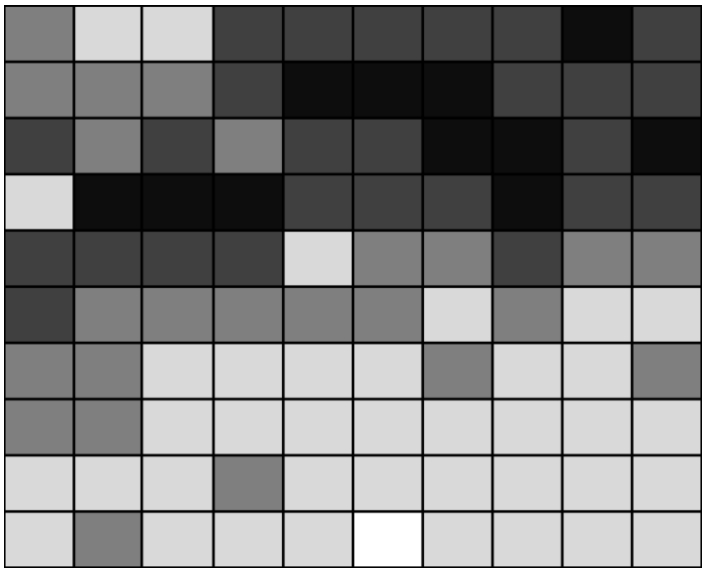

Figure 3. SCN population distribution across a field. Each square is 100 ft^2.

Labs in Ohio that process SCN soil samples collected in Ohio include:

- **C. Wayne Ellett Plant and Pest Diagnostic Clinic (OSU)**
  8995 E Main St
  Reynoldsburg, OH 43068
  614-292-5006
  ppdc@cfaes.osu.edu
- **Spectrum Analytic Inc.- confirmed 2018**
  1087 Jamison Rd. NW
  Washington Court House, OH 43160
  800-321-1562
  www.spectrumanalytic.com
- **Brookside Laboratories, Inc.**
  200 White Mountain Dr.
  New Bremen, OH 45869
  419-977-2766
  info@blinc.com

Step 2: Rotate crops. Once SCN is identified in a field, the best disease management strategy is to keep the numbers low. The best way to keep numbers low is to rotate, rotate, and rotate. Rotating host crops with non-host crops (corn, small grains, and alfalfa) is the most effective method of controlling SCN. Under average Ohio conditions, SCN populations may decline by 50% per year under non-host crops. In fields where SCN populations are high, it may take three years or more of non-host crops between soybean

Table 2. Best SCN management strategies for Ohio soybean producers			
Egg Count Per 100 to 200 cc* of Soil	**Cyst Count**	**Population Level**	**Management Strategies**
0-40	0	None Detected	Continue to monitor field after two crops of soybean
40-200	1	Trace	May begin to measure some yield loss in susceptible varieties at or above 200 eggs/200 cc.
200-2000	1-4	Low	Plant SCN resistant variety or rotate to a non-host crop. At or above 2000 eggs, some yield loss may result on SCN resistant lines.
2000-5000	3-20	Moderate	Rotate to a non-host crop next year and return with SCN resistant soybeans the following year. Losses of 25-50% have been recorded in Ohio on susceptible varieties when grown at these populations.
5000 and over	15-20+	High	Rotate to a non-host crop for two to three years, then sample the soil to determine nematode populations before planting SCN resistant varieties.
*100 to 200 cc = approximately ½ to 1 cup			

crops to reduce SCN populations significantly. SCN populations will not be eliminated in these fields. If soybeans are repeatedly planted for several years, SCN will again become yield-limiting. SCN populations can increase 10 to 40 fold per year on susceptible soybeans. SCN can also reproduce on many legume crops and weeds, including purple deadnettle and henbit (Table 3). These are common winter weeds of no-tillage fields. They emerge from September through early November, and they can increase the SCN population before winter. Because of this, winter annual weeds should be controlled as soon after crop harvest as possible.

Step 3: Use resistant soybean varieties wisely. There are currently two major sources of resistance in commercial varieties: PI88788 and Peking. Ohio now has some fields with sizable SCN populations that can reproduce on the soybeans developed with PI88788 resistance. Resistant varieties should be used in crop rotation with non-host crops to prevent the buildup of SCN in that field. The resistance in commercial soybean varieties is not complete resistance; it's a type of resistance known as partial resistance. In research, resistance to SCN is defined as less than 10% reproduction on the resistant variety compared to a susceptible variety. Resistant varieties should not be planted in fields with high numbers of SCN and varieties having the same source of resistance should not be planted repeatedly in the same field. Doing so may select for types of SCN that can reproduce on resistant varieties. Also, large numbers of SCN juveniles will puncture and damage roots of resistant varieties even if the nematodes cannot reproduce, leaving the SCN-resistant variety susceptible to other soil-borne pathogens.

The female index (FI) is the best way to check for the true level of resistance in individual varieties. FI is determined in greenhouse assays where the average number of female

Table 3. Other hosts of SCN	
Crop Plants	***Weed Plants***
Aslike clover	*Hemp sesbania*
Bird's foot trefoil	Common and mouseear chickweed
Green beans, dry beans	Common mullein
Common and hair vetch	Henbit
Cowpea	Milk and Wood vetch
Crimson clover	Pokeweed
Crown vetch	Common purslane
Lespedezas	Spotted geranium
Pea	Wild mustard
White and yellow lupine	Purple deadnettle
Sweet clover	Field pennycress
	Shepherd's-purse

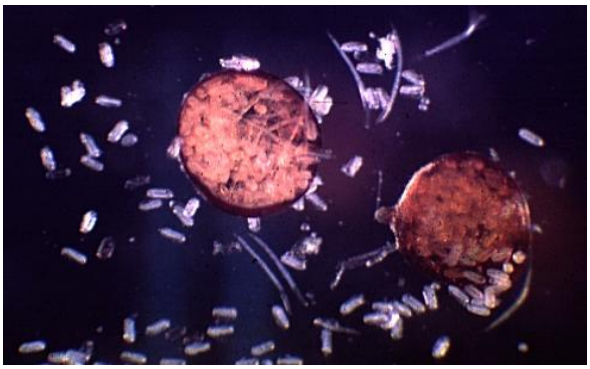

Figure 4. *A cyst cut in half under the microscope showing the hundreds of eggs, and some juveniles, contained inside.*

cysts on a resistant cultivar is divided by the average number of female cysts on a susceptible cultivar and multiplied by 100. If the FI is less than 10 the cultivar is considered resistant. For most areas, the susceptible cultivar Lee 74 is included in the assay for comparison. The FI is currently only evaluated in a few locations. There is variability among SCN populations and more research is in progress to assess the best means to implement this across states.

Step 4: Use best management practices.

- Fertility—Maintain optimum fertility based on a soil test. Under high SCN populations, even the most fertile fields will be severely affected; fertilization will not eliminate the problem.
- pH—Studies in Wisconsin have shown that soil pH has an effect on the level of yield loss caused by SCN. SCN populations were highest in areas of the field with the highest soil pH (7.1–8.0 vs. 5.8–6.4). Likewise the yield advantage of SCN resistant varieties was greatest in high pH soils and lowest in low pH soils.
- Optimize planting/harvesting dates for the maturity group for your region.
- Optimize drainage for proper plant growth.

Step 5: Manage other diseases. Sudden death syndrome and brown stem rot interact with SCN. With SCN many of these diseases can have a larger impact than if the plants were infected separately. Choose varieties that are resistant to these and other Ohio soil-borne pathogens.

Step 6: Prevent introduction. This is the first line of defense. Nematodes can move no more than a few inches a year on their own, so they depend on "hitching rides" on anything that can move soil, such as field machinery, migratory birds, floodwater, or wind. Plant seeds that have been thoroughly cleaned to remove soil particles. SCN can also be introduced into a field by animals, flooding, or wind-blown dust.

HG Types. Some SCN populations are capable of reproducing on resistant soybean varieties. This information is used primarily by seed companies to help make better breeding decisions for the development of varieties for specific regions.

"HG" stands for the scientific name for SCN, Heterodera glycines. An HG Type is a description of an SCN population that is able to develop and reproduce on one or more resistant soybean lines. The number or numbers in the HG Type designation correspond directly to sources of resistance used in available SCN-resistant soybean varieties as seen in the table below. HG Type applies to the nematode, not to the soybean. For example, HG Type 0 will not attack any source of resistance, HG Type 2 will only reproduce on PI8788, and HG Type 1.4 will only reproduce on Peking and PI437654 (Table 4). Some states may use an "SCN Type" to quantify which resistance can be deployed in a field, but this test includes only the sources of resistance used in that state. For example, only #1 (PI 548402 or Peking), #2 (PI 88788), and #4 (PI 437654) are used in Ohio.

Table 4. Codes for soybean plant introductions (PI) used in the HG Type test

1	PI 548402	Peking
2	PI 88788	
3	PI 90763	
4	PI 437654	Hartwig
5	PI209332	
6	PI 89772	
7	PI 548316	Cloud

Useful References

Ohio Field Crop Disease http://www.oardc.ohio-state.edu/ohiofieldcropdisease/ soybeans/scn.htm

SCN Coalition website: https://www.thescncoalition.com/

NSCRP—Plant Health Initiative http://planthealth.info/scnguide/index.html