

Soybean Cyst Nematode: Diagnosis and Management

Allen Wrather and Melissa Mitchum
Division of Plant Sciences



Figure 1. Your field could look like this, yet you could lose 30 percent of your yield to soybean cyst nematode.

Soybean cyst nematode (SCN) is the most devastating and yield limiting pest of soybean in Missouri. A three-year study done in the United States estimated that soybean cyst nematode (*Heterodera glycines*) caused annual losses of \$720 million (120 million bushels).

It is often difficult to identify fields with SCN infestations because lower yield at harvest may be the only aboveground symptom (Figure 1). Yields may decrease slowly for a number of years before the reduction becomes obvious. Suspect fields usually have plants of different heights, but environmental conditions may make stunting less obvious.

When SCN is present and plants are under stress, symptoms such as chlorosis (Figure 2), plant stunting, and (in extreme cases) plant death can occur. However, these indicators are similar to those observed with other crop production problems such as nutrient deficiencies, herbicide damage and drought stress.

White (or yellow) females on roots are the only visible sign of SCN infection (Figure 3). From late June through July, plants exhibiting chlorosis or stunting can be dug in the field and the roots examined for the presence of white females or young cysts on the roots.

Note: Do not rely on visual inspection for diagnosis, because once the cysts have matured, they turn brown and fall off the roots.



Figure 2. Stunted, yellow soybean plants (foreground) are a sign of infection by soybean cyst nematode.

Many fields in Missouri and other Midwestern states are now farmed under reduced tillage. Numerous studies have been conducted in Missouri and other states on the effects of minimum tillage on soybean cyst nematode. Lowered numbers of SCN eggs have been observed in some studies, but the decrease in eggs was not dramatic enough to adopt minimum tillage to manage SCN. Soil erosion management is a much better reason to adopt minimum tillage.

SCN is difficult to detect

- SCN infestation can go unnoticed until damage is severe.
- SCN requires trained observers to detect cysts on the roots and lab analysis to detect them in soil.

SCN is difficult to manage

- SCN can survive in the soil under adverse conditions within cysts.
- SCN lives in the soil environment, which is difficult to manipulate.
- Plant resistance to SCN is not complete.
- SCN can reproduce on at least 97 legume hosts and on 63 other plant species.
- Because of its adaptability, SCN can build up on previously resistant varieties.
- SCN can be suppressed but not eliminated.

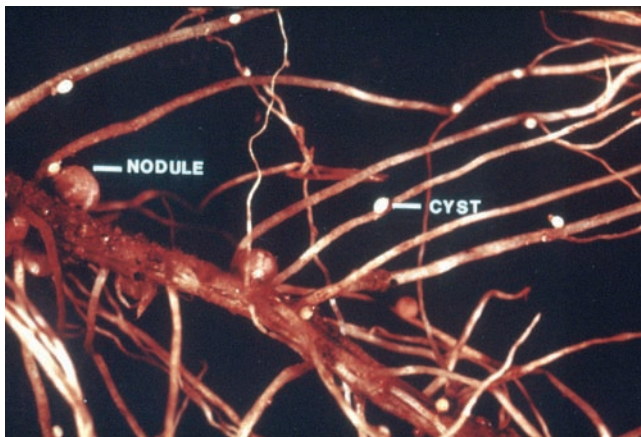


Figure 3. White cyst of SCN attached to soybean root adjacent to soybean nodule.

The most accurate way of determining whether SCN is present in a field is to have the soil tested in a nematology lab for the presence of SCN eggs. Sampling efficiency and laboratory cyst extraction are not 100 percent effective, however, and a significant number of SCN eggs need to be present in the soil for lab detection.

Life cycle of the nematode

Nematodes are one of the largest, most diverse groups of multicellular organisms and are second only to insects in abundance. Nematodes are animals that have a wormlike appearance. Most nematodes are beneficial organisms that help decompose organic matter, releasing nutrients for plant uptake.

SCN is a plant-parasitic nematode that changes shape as it goes through its life cycle. The worm hatches from an egg (Figure 4) and penetrates soybean roots. In the root, juveniles become males or females. Males return to the original wormlike shape and leave the roots in search of females. Those that become females lose the ability to move, enlarge into a lemon-shaped “white female,” which breaks through the root surface, dies, and turns into a brown cyst or egg case (Figure 5). A single nematode cyst may contain several hundred eggs. The majority of eggs remain within the cyst, where they are protected from drying out and from soil predators. There can be more than one generation of SCN during a single growing season, leading to multiple root infestations.

The number of juveniles entering the plant root soon after plant emergence can have a dramatic effect on plant growth and development. Plant damage occurs from juvenile feeding, which removes cell materials and disrupts the vascular tissue. In short, SCN infection inhibits the growth and functioning of the soybean root system, interfering with nutrient and water uptake. SCN infection can also reduce nodule formation by nitrogen-fixing bacteria and can increase plant damage when other plant pathogens are present in the soil.

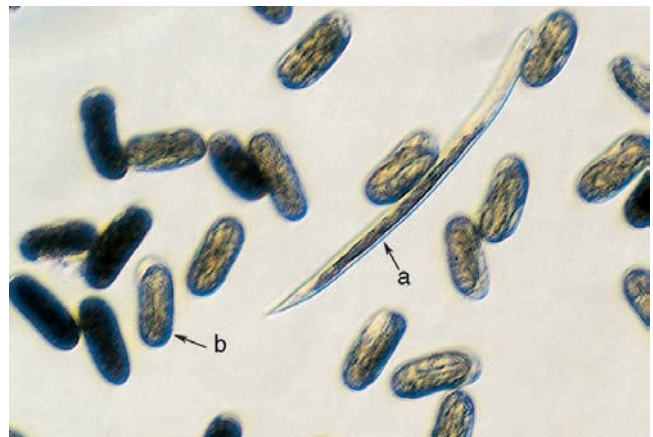


Figure 4. Second-stage juvenile (a) hatched from eggs (b). The juvenile infects the roots. Magnified 500 times.

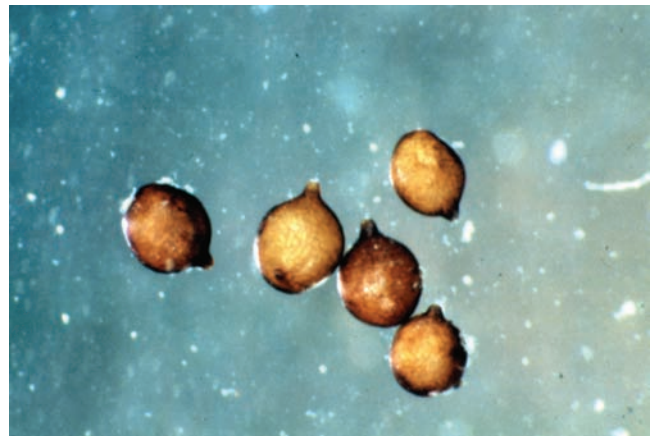


Figure 5. These mature brown SCN cysts full of eggs were collected from soil.

SCN races and resistant soybean varieties

The race of a population of SCN is defined by comparing its reproduction on a set of four soybean germplasm lines with that on a standard SCN-susceptible soybean cultivar. The most commonly used race scheme identifies 16 races of SCN. The race designation allows nematologists and soybean breeders to share information about the ability of certain SCN populations to reproduce on soybean varieties that contain certain genes for resistance to SCN.

In 2003 an improved SCN race test was developed. The HG Type Test is an expansion of the old race test. This new test includes seven sources of resistance (germplasm lines) and the results are shown as a percentage, indicating how much the nematode population from a soil sample increased on each of the seven lines. This test indicates which sources of resistance would be good for the field being tested and which would be poor. Since the genetic sources of resistance are limited in commercially available soybean varieties, it is important to rotate these “sources of resistance” to delay the build up of a virulent SCN population.

Not all varieties with the same source of resistance

have comparable yields, nor do they respond identically to SCN. Consult Soybean Variety Trial data for SCN-resistant soybeans that are adapted to your region.

SCN egg distribution

A soil analysis is the only way to determine whether SCN is present at detectable levels in a field. It is estimated that even when 2 million eggs are present per acre of soil, there is only a 63 percent chance of detecting one egg if one pint of soil is examined. Distribution of SCN in a field is neither random nor uniform. Numbers of SCN and extent of SCN-related plant damage will depend on soil type, soil temperature, soil moisture, overwinter survival of SCN, soil nutrient level, crop host status (host or nonhost), and the presence of other plant pathogens or natural enemies of SCN. A good soil sampling pattern will ensure that a reliable average of the SCN populations is obtained. One cannot reduce yield loss from SCN if soil samples are not representative of the field.

Sampling fields for SCN

Once a field is known to be infested with SCN, soil samples need not be collected each year. Soil samples from these fields should be collected before SCN-susceptible varieties are grown again or once every three years if resistant varieties are grown in a rotation.

Although soil samples for SCN may be collected at any time, the ideal time to sample is as close to soybean harvest as possible. SCN numbers tend to be highest when the plants are almost mature to shortly after harvest. Sampling near harvest allows sufficient time for the nematode laboratory to process the sample and provide you with information, and enough time for variety selection or choosing alternative crops for the next year.

Large fields may be subdivided into sections of about 10 acres each and a single sample from each of the different sections submitted for analysis. Collect 10 to 20 soil cores six to eight inches deep in a zigzag pattern across the area to be sampled. Bulk the cores in a bucket and mix thoroughly. Place about one pint of mixed soil in a plastic bag and label the outside of

SCN egg count recommendations

Fields should be sampled and tested for soybean cyst nematodes (SCN) in the fall before soybeans are planted the following spring. Test results will help you plan for the spring planting and also reduce your risk of SCN infestation. Check the University of Missouri Plant Nematology Laboratory (<http://soilplantlab.missouri.edu/nematode/eggcount.htm>) for possible updates of the following recommendations:

First scenario

If no SCN eggs are detected or a low egg level is found, soybeans without SCN resistance may be planted if the egg count is below the damage threshold of 500 eggs per cup (250 cm³) of soil.

Precautions:

- If no eggs are detected, sample fields every 2 to 3 years at harvest. This increases the probability of finding the nematode if it is present in the field.
- Monitor areas of the field where SCN is likely to be introduced, such as field entrances, areas that flood, fencerows or places where waterfowl congregate. If fewer than 500 eggs are detected, sample after a susceptible variety is grown.

Second scenario

If a moderate egg level is found, plant SCN-resistant soybeans if the egg count is above the damage threshold of 500 eggs per cup of soil and below 10,000 eggs per cup of soil. However, if the egg count in the field is greater than 2,000 eggs per cup of soil, reduced yield can be expected even with resistant varieties.

Precautions:

- Rotate sources of SCN resistance whenever possible.
- If varieties with different sources of resistance to SCN are not available, then grow a different SCN-resistant variety every year soybeans are planted.
- Resistant varieties increase selection pressure on the nematodes. This can reduce the long-term effectiveness of the resistance.

Third scenario

If a high egg level is found, plant a nonhost if egg counts are above 10,000 eggs per cup of soil. SCN nonhost crops include alfalfa, barley, canola, clover (red, white, ladino), corn, cotton, forage grasses, oats, rye, sorghum, tobacco and wheat. Alternatively, plant onl SCN-resistant soybean varieties.

Precautions:

- Rotate nonhost plants with SCN resistant soybean varieties.
- An HG type "race" test may be appropriate if the egg count is more than 10,000 eggs per cup of soil, and the egg count is increasing despite the use of resistant varieties.

the bag with a marker to identify the field number and owner. Store the sample away from sunlight in a cool area until it is shipped to the laboratory (<http://soil-plantlab.missouri.edu/nematode/samples.htm>).

Testing for SCN

The University of Missouri Plant Nematology Laboratory will determine the number of nematodes or nematode eggs present in soil samples. The following tests are available.

Soybean cyst nematode count

Determines SCN presence (above detectable levels) and severity of infestation. Requires at least one pint of soil.

Cost: \$15 per sample

Soybean cyst nematode HG type "race" determination

Suggested if SCN-resistant soybeans have been grown for several years and SCN egg counts are rising. Requires at least one gallon of soil from a heavily infested field.

Cost: \$50 per sample, Missouri
\$100 per sample, out of state

Send your soil samples to

Plant Nematology Lab
23 Mumford Hall
Columbia, MO 65211
Phone: 573-884-9118

Managing soybean cyst nematode

Uninfested fields

Avoid introducing SCN whenever possible. SCN can be spread on anything that moves soil. It is not possible to eradicate SCN from a field once it has become established. Work uninfested fields first to avoid spreading SCN in soil.

Infested fields

Rotation. Rotate soybeans with crops that are not SCN hosts. SCN cannot reproduce if host plants

Manage SCN through crop selection

Some SCN nonhosts

Alfalfa	Forage grasses
Barley	Oats
Canola	Rye
Clover (red, white, ladino)	Sorghum
Corn	Tobacco
Cotton	Wheat

SCN hosts

Beans (snap, bush, green, mung, kidney)	Henbit
Burclover	Hop clover
Birdsfoot trefoil	Lespedeza
Clover (alsike, crimson, scarlet)	Lupine, white and yellow
Common and mouse-ear chickweed	Peas
Common mullein	Pokeweed
Cowpea	Purslane
Ground cherry	Spotted geranium
Hemp sesbania	Sweet clover
	Vetch (common, hairy, winter, crown)
	Winged pigweed

are not present. Rotate sources of genetic resistance in soybean varieties if possible. A certain percentage of SCN individuals can reproduce on resistant varieties. If sources of resistance are not rotated, these individuals can produce a SCN race shift. This will reduce the effectiveness of genetic resistance available in commercial soybean varieties.

Maintaining plant health. Plant stress from drought, nutrient deficiencies, weed infestation, insects, and other plant diseases will aggravate plant damage caused by SCN.

Resistance vs. nematicides. Resistant germplasm is more reliable and cost-effective than nematicides in reducing SCN populations.

Weed control. Reduce weeds in fields, because weeds can also be SCN hosts.

Essential facts about SCN

- Yield loss of 30 percent of your crop is possible without any obvious problem until harvest.
- Eggs can survive in the soil for many years even when a host plant is absent.
- Nematode reproduction occurs on resistant soybeans.
- SCN can move every way that soil moves.
- SCN can be present in a field for many years before it is detected.
- SCN symptoms may look like those due to other causes.