SDSU Extension

iGrow Soybean

BEST MANAGEMENT PRACTICES

Chapter 57:
Soybean Cyst Nematode

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Soybean cyst nematode (SCN) was first identified in the United States in 1954. In South Dakota, SCN was first detected in Union County in 1995 and is currently found in 27 counties. Beadle County was recently added in mid-2012 (Fig. 57.1). In annual surveys of scientists working with soybean throughout the country, soybean cyst nematode was ranked as the top yield-limiting disease in the country. The latest estimate indicated that soybean cyst nematode robbed over 134,000 ton of soybean yield per year in South Dakota. This chapter provides information on signs and symptoms, life cycle, and SCN management.

Causal organism

Soybean cyst nematode, Heterodera glycines, is a microscopic roundworm (the adult is about 1/32 inch long) that attacks the roots of soybean; several other leguminous crops, such as cowpea, dry beans, and crimson clover; and a number of weeds (Table 57.1).

Table 57.1. Examples of host and non-host plants of soybean cyst nematode.

Host Crops	Weed Hosts	Non-hosts
Birdsfoot trefoil	Common chickweed	Alfalfa
Edible beans	Common mullen	Canola
Clover (Aliske, Crimson, Sweet)	Field pennycress	Clover (Red, White, Ladino)
Cowpea	Henbit	Corn
Lupine (White, Yellow)	Purslane	Small grains (barley, oats, rye, wheat)
Soybeans	Sericea lespedeza	Sorghum (grain and forage)
Vetch (Comon, Crown, Hairy)	Wild mustard	Sugar beets

Genetic variability occurs within the SCN populations in the United States. This genetic variability allows different SCN populations to overcome different sources of resistance in soybean. In the past, a scheme classifying the SCN population into different races based on the population's response towards four known sources of resistance was used (PI 88788, PI 90763, Pickett and Peking).

The race designation was relatively close-ended and could not take into account newer sources of resistance. Thus, a new classification scheme that is open-ended to include newer sources of resistance was proposed in 2002. This new classification scheme has been widely used. In this new scheme, a population of SCN is inoculated to several indicator lines associated with different sources of resistance (Table 57.2) and a susceptible check. The population is then classified to different HG (Heterodera glycines)-types based on its observed virulence on various indicator lines.

Table 57.2. Indicator lines for HG-Type classification of SCN.

Number	Indicator Line
1	PI 548402 (Peking)
2	PI 88788
3	PI 90763
4	PI 437654
5	PI 209332
6	PI 89772
7	PI 548316 (Cloud)

Virulence is measured with a Female Index (FI), calculated as the percentage of the number of females found on a particular indicator line compared to the number of females found on the susceptible control. If the average Female Index on an indicator line is greater than ten, the population is considered virulent for the respective line.

In the HG-type scheme, more indicator lines can be added as new sources of resistance are developed, thus it is considered "open-ended." Furthermore, a designation of a population HG-type does not have to take into account all possible indicator lines. The "-" following some of the HG-type designations in Table 57.3 indicates that the test did not take into account all possible indicator lines.

In practice, HG-typing helps assessing whether a resistant soybean variety derived from a particular resistance source will be effective against a certain SCN population. For example, a grower notices that the performance of an SCN-resistant soybean variety has been declining periodically. HG-typing the SCN population found in the field may help pinpoint the problem by ascertaining whether the population is able to overcome the particular source of resistance used in the variety.

An example of HG-type classification of some SCN populations is illustrated in Table 57.3. Of the three samples assayed in Table 57.3, sample numbers 14 and 59 are classified as HG-type 2. In this case, SCN in these samples will be able to reproduce in soybean varieties with PI 88788 as their resistance source. This is valuable information when choosing resistant varieties in the face of perennial SCN problems.

Table 57.3. HG-Types of some SCN populations collected in southern Illinois during 2004. (Niblack et al., 2006)

Sample Number	Female Indices on PI 548402	Female Indices on PI 88788	Female Indices on PI 437654	HG Type
#14	7	32	0	2-
#57	7	8	0	0-
#59	19	13	0	1,2-

Symptoms and signs

Above-ground symptoms of SCN infection are not always visible. A soybean crop may lose as much as 30% of yield due to SCN without showing above-ground symptoms. Consequently, it is quite common to have an infestation of SCN in a field for several years before the presence of the worm is suspected or detected. Areas that have yields that are below expectations may indicate the presence of SCN. Yield maps can be very helpful in identifying areas for intensive scouting of SCN.

When symptoms are present, they are first manifested as a slight variation in height of otherwise healthy-looking, dark-green plants, sometimes described as “rollercoaster-ing” of soybean rows. High SCN levels may induce leaf yellowing, plant stunting (Fig. 57.2), and plant death. These symptoms are easily confused with potassium deficiency, nitrogen deficiency, iron chlorosis, herbicide injury, soil compaction, and several soybean diseases. Fields with high SCN population densities may have elliptic, circular, or elongated areas with severe above-ground symptoms. Sometimes the areas of plants showing clear above-ground symptoms follow the tillage patterns.

Diagnostic signs of SCN infection can be found by digging roots from the soil and searching for females or cysts on the root surface. Female SCN appears as pearly white or yellow lemon-shaped bodies on the root surface, visible to the unaided eye (Fig. 57.3). The cysts, being a dead body of the females encapsulating viable eggs, are of a similar shape with the females, but brownish in color. It takes several weeks from planting to actually observe these diagnostic signs on infected roots. Swollen females are common on smaller roots and much less common on the taproot. The females and cysts are readily lost when digging plants in very dry soil as the smaller roots that are most commonly infested may be left behind when digging the plants.

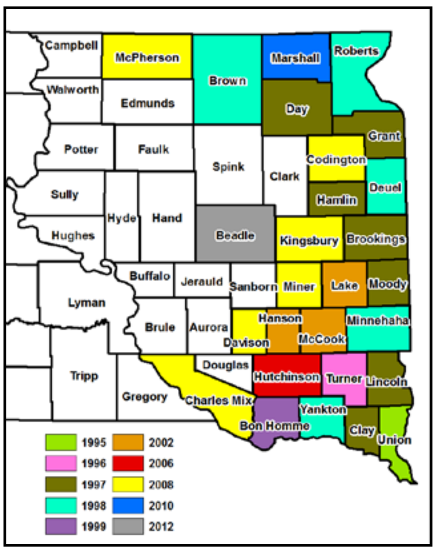


Figure 57.1. South Dakota counties where SCN has been detected and the year of detection.

Figure 57.2. Above-ground symptoms of SCN infection. The first two rows from the left appeared yellowed and stunted, typical above-ground symptoms of SCN infection, compared to the rows on the right. (Photo courtesy of Erik Stromberg, Virginia Polytechnic Institute and State University, Bugwood.org)

Life cycle and epidemiology

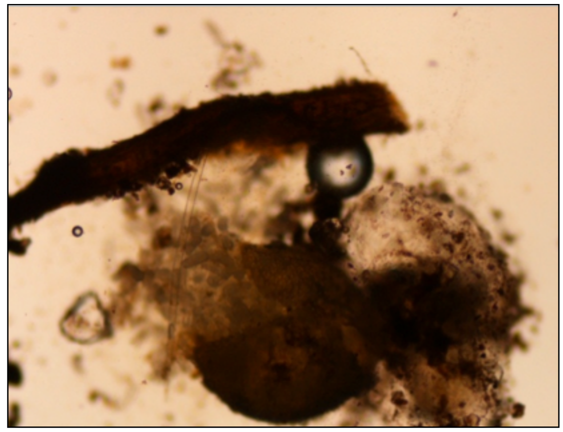
Soybean cyst nematodes undergo several phases in their life cycle. The eggs serve as the survival means for SCN, a portion of which are retained within the cyst. The cyst acts as an extra protective layer to these eggs. The juveniles hatching from these eggs move freely and actively enter the roots of soybean plants. Within the roots, the nematodes induce the development of a specialized feeding site.

Soybean cyst nematode infection of soybean roots stunts roots and reduces the number of nitrogen-fixing nodules which results in the disruption of water and soil nutrient intake. Soybean cyst nematode feeds directly on the root. Infected plants develop fewer pods and produce lower yields. Feeding damage by SCN also predisposes the plants to infection by other root-infecting pathogens, especially fungal pathogens causing sudden death syndrome and brown stem rot.

The nematodes grow in size and develop into adult males or females. The SCN females eventually become large enough that they rupture out of the roots and are visible on the root surface (Fig. 57.3). The SCN males retain a vermiform (worm-like) shape in its adulthood (Fig. 57.4), move out of the roots, and mate with the females. The mated SCN females lay some of their eggs in gelatinous masses deposited on the rear of the body. The females also retain some of the eggs within their bodies. The female SCNs eventually die with the viable eggs still stored within their body cavities. The dead nematodes' body walls form cysts that protect the eggs inside (Figs. 57.5 and 57.6).

Figure 57.3. Soybean roots with SCN females. (Photo courtesy of Iowa State University)

Figure 57.4. A microscopic view of soybean cyst nematode male. (Photo courtesy of Agroscope FAL Reckenholz Archive, Swiss Federal Research Station for Agroecology and Agriculture, Bugwood.org)

(Left) Figure 57.5. A close up view of SCN cyst on a soybean root. (Photo courtesy of Iowa State University)
(Right) Figure 57.6. A ruptured SCN cyst revealing the eggs within. (Photo courtesy of Connie G. Tande, SDSU)

Under a constant temperature of 77ºF (25ºC), the life cycle of SCN can be completed in 21 days. In the field, temperatures and soil moisture levels conducive for soybean growth are also optimal for SCN population development. The SCN population density in the beginning of a soybean season is a critical factor determining yield loss. Thus, management strategies for SCN should be developed and implemented as soon as the presence of SCN within a field is confirmed.

Management approaches

Effective SCN management includes using an effective rotation that includes non-host plants (corn, wheat, and grain sorghum), cleaning equipment between fields, confirming SCN by soil sampling, and planting SCN-resistant cultivars. In making these decisions, it is important to ascertain whether a field is infested with SCN. Since above-ground symptoms of SCN infection are not always apparent, field soil testing for the presence of SCN in areas with SCN history is crucial.

Scouting

To confirm an SCN problem, soil samples can be collected systematically and tested for SCN cysts and eggs. Divide the field into 10- to 20-acre sections and sample each section separately. Within a section, walk a zig-zag or an M pattern path and collect 10-20 soil core samples (6-8 inches or 15-20 cm deep). Use a cylindrical soil probe to collect the soil core samples from around the root area. Specifically include soil samples from high-risk areas where nematodes may have been introduced to the field, such as field entrances, fence lines, areas with occasional flooding, and areas with unexplained low yield. Bulk the core samples from a section and mix it thoroughly in a bucket.

Place 1 pint (0.55 L) of mixed soil in a plastic bag, label the bag with the field information and date of collection, and keep it in a cool and dark environment until shipping.

Send the soil samples to:

SDSU Plant Diagnostic Clinic
Box 2108
SPSB 153
Plant Science Building
Brookings, SD 57007

(As of the writing of this chapter [August 2012], SCN testing at the SDSU Plant Diagnostic Clinic is provided free of charge to residents of South Dakota. This free service is made possible through funding provided by the South Dakota Soybean Research and Promotion Council.)

Soil samples can be collected at any time, but the optimal time to sample for SCN is as close to soybean harvest as possible. The presence of SCN in a field may also be confirmed by carefully digging plants in late

July or August and examining roots for white females (Fig. 57.3). The SDSU Plant Diagnostic Clinic does not conduct HG-type assay. SCN detection at the SDSU plant clinic simply ascertains whether the samples taken from the field contain SCN. If the results show that SCN is present in the field, growers may want to consider incorporating several cultural practices to manage SCN in their fields.

Cultural practices

The impact of SCN infection is exacerbated on stressed plants. Providing optimal crop growth conditions by paying careful attention to soil fertility and weed management reduces the yield loss due to SCN infection.

Soybean cyst nematode is an obligate parasite that, once hatched, requires the presence of susceptible hosts to mature and multiply. Thus, incorporation of non-host crops, such as corn, wheat, grain sorghum and other crops (Table 57.1) in a rotational scheme will reduce SCN populations. Short-term use of a non-host crop will not eliminate the SCN population from an infested field since the nematode eggs may survive for years in the absence of host crops.

In a controlled storage environment, Inagaki and Tsutsumi (1971) showed that eggs within SCN cysts could remain viable for as many as 11 years. The amount of SCN population reduction due to non-host crop rotation varies with geographic location. In the northern plains, a rotation scheme that includes two or more years of a non-host crop before planting soybean is recommended. Unfortunately, the economic values of the alternative non-host crop are, at times, limited. In this case, a rotation scheme should incorporate resistant and tolerant soybean varieties. Care should be taken to use SCN-resistant soybean varieties with different sources of resistance in a rotation to avoid the buildup of SCN populations that can become virulent on a source of resistance.

Avoiding such a buildup of SCN populations can also be achieved by planting tolerant/susceptible varieties as a part of the rotation scheme. Even though tolerant varieties do not limit the growth of SCN population feeding on their roots, SCN infection on tolerant soybean varieties causes lower yield loss than infection on non-tolerant varieties.

Because SCN is moved with soil, sanitation practices that limit movement of soil from one field to another should be practiced. Such practices include cleaning tillage and harvest equipment between fields.

Host plant resistance

Soybean varieties with resistance to SCN are widely available. Even though SCN can still survive and multiply on resistant soybean varieties, its population growth is more limited and the population of the pest is often suppressed. Consequently, soybean varieties with SCN resistance typically produce higher grain yield than susceptible varieties when planted in SCN-infested fields. There are a number of sources of SCN resistance used in public and private breeding programs. The soybean accession PI 88788 is a very common source of resistance. Other sources of SCN resistance include PI 90763, PI 209332, PI 437654, Peking, and Hartwig. As noted in the cultural practices section above, it is advisable to use soybean varieties from different sources of resistance in a rotation.

Chemical control

A number of seed treatment products are currently marketed to protect soybeans from SCN, including ones with abamectin or a biological agent, Bacillus firmus, as the active ingredient. Trial of various seed treatments conducted in 2011 and 2012 at Hurley and Beresford (South Dakota) showed inconsistent results in terms of SCN population control. While numerical difference can be detected between the average yield of treated and untreated seeds, no statistical difference was detected between treatments.

References and additional information

Inagaki H. and M. Tsutsumi. 1971. Survival of the soybean cyst nematode, Heterodera glycines Ichinohe (Tylenchida: Heteroderidae) under certain storing conditions. Appl. Entomol. Zool. 6:156–162.

Niblack, T.L., K. N. Lambert and G. L. Tylka. 2006. A model plant pathogen from the kingdom animalia: Heterodera glycines, the soybean cyst nematode. Annu. Rev. Phytopathol. 44:283–303.

Plant Management Network website has a series of timely webcast on soybean management. Some of the topics in this series are highly pertinent to soybean cyst nematode management. Available at http://www.plantmanagementnetwork.org/infocenter/topic/FocusOnSoybean/

Soybean cyst nematode management guide. Currently in its 5th edition, the guide sponsored by North Central Soybean Research Program is a regularly updated management guide based on field research contributed by multiple states. South Dakota State University faculty regularly contribute to the research informing this guide. Available at http://www.planthealth.info/pdf_docs/SCNGuide_5thEd.pdf

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