Soybean Cyst Nematode

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The soybean cyst nematode (SCN), *Heterodera glycines,* is a small plant-parasitic roundworm that attacks the roots of soybeans. Most nematodes can be observed only with magnification, but the adult females and cysts of SCN are about '/32 of an inch long and visible to the unaided eye.

Several kinds of plant-parasitic nematodes have been present in Iowa soils since long before the land was used for agriculture. However, SCN is relatively new to Iowa. It probably was introduced into the state 20 to 25 years ago and was first confirmed in Winnebago County in 1978.

The presence of SCN is not usually obvious at the time of initial soil infestation. The nematode population density must increase in the soil until it is sufficient to cause above-ground symptoms on plants or a decrease in yield. Population densities may take several years to reach significant numbers. Thus, current SCN damage to soybeans is the result of infestations that have been growing for several years.

Most likely, SCN came from Japan where it was first reported more than 75 years ago. The first reports of SCN in the United States came from North Carolina in 1954. Since then it has been found in 25 more states in the Southeast and Midwest, including Illinois, Minnesota, Missouri, Nebraska, and Wisconsin.

Symptoms

Above-ground Symptoms

Above-ground symptoms of SCN damage are not unique to SCN. They often are mistaken for damage from compaction, iron deficiency chlorosis and other nutrient deficiencies, drought stress, herbicide injury, or other plant diseases. SCN injury often has remained undetected for several years because these nondescript symptoms were attributed to other causes.

Figure 1. Area of soybean cyst nematode damage in a soybean field.

Figure 2. Rows of stunted, chlorotic soybean plants damaged by soybean cyst nematode are slow to fill in with foliage.

The first obvious symptom of SCN injury to soybeans is the appearance in the field of circular- or oval-shaped areas of stunted, yellowed, less vigorous plants (figure 1). These infested areas will vary in their size, often showing a sharp dividing line at the edges between stunted and apparently healthy plants. Plants growing in heavily infested soils may remain stunted throughout the season. Rows of soybeans grown on SCN-infested land frequently are slow to close or fill in with foliage (figure 2).

Figure 3. Adult female of soybean cyst nematode with egg filled egg sac (magnified approximately 25 times).

In areas with high pH soils, the yellowing of soybeans due to SCN often is confused with iron deficiency chlorosis. However, there are differences between symptoms of the two problems. Iron deficiency chlorosis symptoms usually appear in early June, whereas yellowing due to SCN will more likely occur in July and August. The yellowing caused by iron deficiency chlorosis typically affects the areas between the veins of the upper leaves. Yellowing due to SCN usually starts at the edges of the leaves, and can affect leaves on the entire plant. Iron deficiency chlorosis and SCN may occur in the same field and even on the same plant.

An area of SCN damage often will appear elongated in the direction of tillage operations. Most severe damage is often in the center of the area, with damage decreasing towards the margins. Such areas frequently develop near a field gate, entrance, wherever equipment enters a field, or near fences where wind-blown soil may accumulate.

The above-ground symptoms of SCN damage do not always occur consistently. Symptoms range from nonexistent to severe depending on the age and vigor of the soybean plants, SCN numbers, soil fertility, moisture levels, and other environmental conditions. Injury usually is more severe in light, sandy soils, but it also occurs in heavier soils. SCN damage is not always confined to smaller areas within a field. Some fields in Iowa are infested with SCN throughout; in such fields, areas of stunted

plants are not obvious because the size of plants throughout the field is much the same.

Figure 4. Yellow soybean cyst nematode cysts on soybean roots. Note the small size of the cysts (upper pointer) relative to the larger nitrogen nodule (lower pointer).

One cannot rely upon above-ground symptoms for identification of SCN infestations. If soybean yields in any field have decreased for no apparent reason, or if SCN has been confirmed on nearby land, more thorough examination of plants for below-ground symptoms and a soil analysis for SCN are needed.

Below-ground Symptoms

Most below-ground symptoms of SCN damage are not unique. Roots infected with SCN are dwarfed or stunted. SCN can decrease the number of nitrogen-fixing nodules on the roots. SCN infections also may make the roots more susceptible to attacks by other soil-borne plant pathogens. Often it is difficult to recognize if roots are stunted and have fewer nodules unless they are compared to uninfected soybean plants.

The only unique symptom of SCN infection is the presence of adult female nematodes and cysts on the soybean roots (figure 3). These structures, which appear as tiny, lemon-shaped objects on the roots, are white initially, but turn yellow and then tan to brown as they mature. They can be seen with the unaided eye, although observation with a magnifying glass is easier. The cysts are about the size of a pinhead and are much smaller than nitrogen nodules (figure 4). Roots must be carefully removed from the soil for examination or the cysts may be dislodged. **Observation of adult females and cysts on the roots of soybean plants is the only accurate way to diagnose SCN infestation** in **the field.**

Life Cycle

The SCN life cycle has three major stages: egg, juvenile, and adult. The life cycle can be completed in 24 to 30 days under optimum conditions. When temperature and moisture levels become adequate in the spring, worm-shaped juveniles (figure 5) hatch from eggs in the soil. These juveniles are the only life stage of the nematode that can infect soybean roots.

After penetrating the soybean roots, juveniles move through the root until they contact vascular tissue. There they stop and start to feed. The nematode injects secretions that modify certain root cells and transform them into specialized feeding sites. As the nematodes feed, they swell (figure 6) and eventually female nematodes becomes so large that they break through the root tissue and are exposed on the surface of the root (figure 7).

Male nematodes, which are not swollen as adults, migrate out of the root into the soil and fertilize the

lemon-shaped adult females. The males then die, while the females remain attached to the root system and continue to feed. The swollen females begin producing eggs, initially in a mass or egg sac outside the body, then later within the body cavity. Eventually the entire body cavity of the adult female is filled with eggs, and the female nematode dies. It is the egg-filled body of the dead female that is referred to as the cyst. Cysts eventually dislodge and are free in the soil (figure 8). The walls of the cyst become very tough, providing excellent protection for the 200 to 400 eggs contained within. SCN eggs survive within the cyst until proper hatching conditions occur. Although many of the eggs may hatch within the first year, many also will survive within the cysts for several years.

How SCN Spreads

SCN can move through the soil only a few inches per year on its own power. However, SCN can be spread substantial distances in a variety of ways. Anything that can move infested soil (even small amounts) is capable of spreading SCN, including farm machinery (figure 9), vehicles and tools, wind, water, animals, and farm workers. Seed sized particles of soil, called soil peds, often contaminate harvested seed. Consequently, SCN can be spread when seed from infested fields is planted in uninfested fields. There is even evidence that SCN can be spread by birds. Only some of these causes can be prevented.

Figure 5. A vermiform, infective soybean cyst nematode juvenile (shortly after hatch) and an unhatched egg (magnified approximately 75 times).

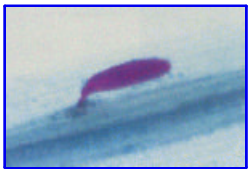

Figure 6. Swollen soybean cyst nematode juvenile within a stained soybean root segment.

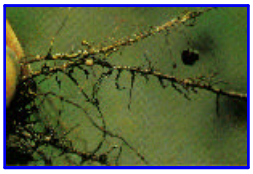

Figure 7. Adult soybean cyst nematode females on an infected soybean root segment.

Soil Sampling for SCN

Individuals may send soil samples to private laboratories or Iowa State University's Plant Disease Clinic for determining SCN egg densities. Soil samples usually are taken in the fall, after harvest, so

that analysis for SCN eggs will provide timely information for use in planning the next season. However, samples may be taken anytime during the season, particularly to confirm if SCN is present in a field. Fields currently in other crops can be sampled too. The time of the year, current crop, rotation, and other available information all factor into the interpretation of the results.

Guidelines

1. Limit the number of acres represented in a single sample to between 1 0 and 20 acres at the very most. The fewer the number of acres included in the sample, the more accurate the results will be.
2. Collect 10 to 20 soil cores with a soil sampling tube, or 1/4 cup soil from 1 0 to 20 locations using a shovel. Soil should be taken from a depth of 6 to 8 inches from within the root zone of the plants (if plants are present). Combine the soil in a bucket and mix well. Place about 1 pint of soil into a plastic bag or paper soil test bag. Avoid storing the samples in the sun, and ship the samples as soon as possible to Plant Disease Clinic, 323 Bessey Hall, Department of Plant Pathology, Iowa State University, Ames, Iowa 50011.
3. Provide the following information for each soil sample by completing the Plant Nematode Sample Submission Form PD-32:
   - ☐ Name, address, and telephone number of farmer and collector;
   - ☐ County and nearest town where samples were collected;
   - ☐ Estimated acreage of areas sampled;
   - ☐ Cropping history of areas sampled; and
   - ☐ Current crop of areas sampled.

The fee for processing the soil sample will be indicated on the Plant Nematode Sample Submission Form PD-32.

Management Practices

Once present in the soil, SCN can never be eliminated. However, the nematode can be managed, which will minimize its reproduction and maximize crop yields. Management practices for SCN fall into five categories.

Figure 8. Soybean cyst nematode cyst broken open to reveal hundreds of eggs (Photo courtesy of E. C. McGawley, Louisiana State University.)

Figure 9. Spring tooth harrow carrying soil infested with soybean cyst nematode.

Plant Health Maintenance

Plants that have adequate moisture and fertility are better able to withstand SCN infection. Consequently, it is more critical for maximizing yield to maintain proper fertility and soil pH levels in SCN-infested land than in uninfested land. It is also important to control other plant diseases, as well as insect and weed pests. Weakened plants are more susceptible to the yield-suppressing effect of the nematode.

Sanitation

Common sense sanitation practices can be very effective in delaying the spread of SCN to uninfested land. If only certain fields on a farm are infested with SCN, plowing, planting, and cultivating of these fields should be done **after** uninfested fields have been worked. After working in infested fields, equipment should be thoroughly cleaned with high pressure water or steam.

Seed grown on infested land should not be used for planting uninfested fields unless the seed has been properly cleaned. SCN may be spread in soil peds associated with the seed.

Host Resistance

Resistant soybean varieties are the most effective tool available for management of SCN. SCN densities usually decrease when resistant soybeans are grown because most SCN juveniles are unable to feed and develop on the roots of the resistant varieties. However, in any naturally infested field, a few SCN juveniles (usually less than 1 percent) will be able to reproduce on the resistant varieties currently available. The number of SCN juveniles that can reproduce on resistant soybean varieties increases when resistant varieties are grown repeatedly. Eventually, the SCN population will be able to reproduce as well on a resistant variety as a susceptible variety if SCN-resistant soybeans are grown every time soybeans are produced in an infested field. Fortunately, the number of SCN juveniles that can reproduce on resistant varieties declines when susceptible soybean varieties are grown because these nematodes do not compete well for food with the other SCN juveniles in the soil that cannot feed on the resistant varieties.

In the past there were few SCN-resistant soybean varieties available for Iowa, but numerous public and private varieties have been released in recent years. These varieties contain SCN resistance genes from the soybean breeding lines "PI88788" or "Peking". Growers are recommended to alternate use of varieties with these two different sources of SCN resistance. Furthermore, a susceptible soybean variety should be grown once after both types of resistant varieties have been used to counter the effects of growing the SCN-resistant soybean varieties. Table 1 outlines a recommended six-year corn-soybean rotation using both types of resistant soybean varieties and susceptible varieties for management of SCN. Growers should consult the county extension personnel or seed company representatives for information on suitable resistant soybean varieties or to further discuss effective crop rotation schemes.

Nonhost Crops

SCN is an obligate parasite and is unable to develop and reproduce in the absence of living host

roots. Consequently, numbers of SCN will decline during any year that nonhost crops are grown. Corn, oat, and alfalfa are nonhosts for SCN, and nematode numbers decline similarly when infested soils are planted with these three crops. Table 2 lists several SCN host and nonhost crops. Most weeds commonly found in Iowa are not hosts for SCN.

Nematicides

There are several nematicides that are labeled for use against SCN, though they generally do not give season-long control. When applied at planting, the effect of the nematicides may last long enough to provide an economic yield benefit. By the end of the growing season, however, SCN numbers may be as high or higher than at planting. No nematicide will kill all SCN in the soil.

The performance of the nematicide will depend on soil conditions, temperatures, and rainfall. A yield benefit is not guaranteed, and nematicides are expensive. Growers are advised to consider economics, as well as environmental and personal health concerns, when considering use of nematicides for management of SCN.

Table 1. Recommended crop rotation scheme for land infested with soybean cyst nematode (SCN) at a low or moderately low level.

1st year	Nonhost*
2nd year	PI88788" SCN-resistant soybeans
3rd year	"Nonhost*
4th year	"Peking" SCN-resistant soybeans
5th year	Nonhost*
6th year	SCN-susceptible soybeans
7th year	(repeat 1st year)

*Nonhosts for SCN include alfalfa, corn, and small grains. See table 2 for a more extensive list of SCN nonhosts.

Table 2. Examples of hosts and nonhosts of soybean cysst nematode.

Host crops	
Soybeans	Vetch (common, hairy)
Beans (green,snap, dry, red, lima, mung, bush)	Lespedeza (Common, Korean, round bush, sericea)
Adzuki beans	birdsfoot-trefoil
Garden peas	Sweetclover
Cowpeas	White lupines

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