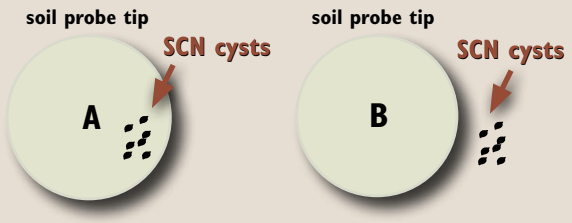
7. Why are SCN numbers variable?

SCN cysts are very small and are usually clustered in the soil, making SCN soil sample results notoriously variable. With a typical 1-inch-diameter soil probe, random placement of the probe into the soil can have a tremendous effect on how many egg-filled SCN cysts are recovered [below].



Variability Diagram
In the diagram, soil probe A (seen in cross-section) captures a cluster of seven SCN cysts (not drawn to scale) that may contain 1,500 eggs. The placement of soil probe B is only $^1/_2$-inch different than the placement of soil probe A and it misses the seven SCN cysts, resulting in up to 1,500 fewer eggs being present in the soil core. *(Tylka)*

In addition, variability in SCN numbers within a field at a single point in time depends on the same factors that affect seasonal changes, including:

- Crop
- Host suitability
- Moisture
- Overwinter survival
- Presence of weed hosts such as winter annuals
- Soil type
- Temperature
- Tillage

Another factor known to affect SCN numbers is soil pH. In SCN-infested fields, nematode numbers may be much higher in areas with pH levels greater than 7.0, compared with areas of pH 5.9 to 6.5. Soil with pH of more than 7.0 was consistently associated with high initial SCN egg density. Soil pH may also govern the degree to which SCN populations increase in a field after its introduction.

Finally, nematode numbers are variable because anything that moves soil will move SCN with it, including wind, water, migratory birds, tillage and harvest equipment and animals. Once introduced into a field, SCN may take up to 10 years to build up to a damaging level, depending on how often susceptible soybean is grown.

8. What are HG Types?

Until recently, SCN-resistant varieties suppressed 90 percent or more of the development of most SCN populations, resulting in a significant increase in soybean yields in SCN-infested fields. However, soon after resistant varieties were first released, scientists discovered that some SCN populations were capable of reproducing at high levels on resistant soybean varieties. A race test was developed in 1970 to assess and describe the abilities of SCN populations to reproduce on resistant soybean varieties. Today we know more about the interaction between SCN virulence and soybean resistance, and we identify SCN populations as HG Types.

Laboratories that offer SCN diagnostic services may or may not be able to provide HG Type tests; it's best to check first.

"HG" stands for the scientific name for SCN, *Heterodera glycines*. An HG Type is a description or profile of an SCN population based on the nematodes' ability to develop on resistant soybean lines. The HG Type test is similar to a race test, but is more informative and easier to understand. The number or numbers in the HG Type designation correspond directly to sources of resistance used in available SCN-resistant soybean varieties (Table 1).

Table 1. The seven soybean plant introductions used in HG type tests.

HG type index number	HG type 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)

**These lines are called plant introductions (PI) because they are the original soybean lines from China or Russia that are the ancestors of every SCN-resistant variety we have today. They are listed in order of discovery of their resistance.*

How the HG Type is determined:

1. **SCN eggs from a field sample are used to infest seedlings of seven different resistant soybean lines (see Table 1) plus a standard susceptible variety.**
2. **The seedlings are grown in a greenhouse for 30 days.**
3. **The SCN females are removed from the roots and counted.**
4. **The Female Index* is calculated for each resistant soybean line.**
5. **If the Female Index is 10 or more on a soybean line, this indicates that SCN populations will increase if it is planted. The number for this line gets added to the HG Type of the SCN population.**

Example 1:

Let's say we test the SCN population from your field, and we get a Female Index greater than 10 on PI numbers 2, 5 and 7 (Table 1). This means the HG Type is 2.5.7.

Example 2:

Let's say the results from a different field show a Female Index greater than 10 on PI numbers 1, 3 and 6. The HG Type of this population is 1.3.6.

Example 3:

The results of the test show that your nematodes cannot attack any of the seven lines listed in Table 1. This means you have an HG Type 0.

** A female index (FI) is simply a percentage: the number of females produced on each resistant line is divided by the number produced on a standard susceptible soybean, and the result is multiplied by 100. A low FI (<10) means that the SCN population was not able to reproduce well on the resistant line, and a high FI means that the SCN population was able to reproduce well.*

What does it all mean to you?

Repeated use of the same resistant variety will result in development of an SCN population that is adapted to that variety. Use of the same resistant variety more than once in the same field is NOT recommended. But many resistant varieties have the same resistant parent, or "source of resistance," and so rotation of resistant varieties alone may not be sufficient to avoid this problem. Nonhosts (see Table 3) must be included in the rotation to decrease the numbers of SCN and slow down its adaptation to resistant varieties. The common sense approach is the best: don't grow the same variety every time you grow soybeans and include nonhosts in the rotation plan.

Do you need an HG Type test?

You may want to have an HG Type test if you have both high SCN numbers and poor yields of SCN-resistant varieties. An HG Type test can help you find the cause and decide what to do. But proper sampling and attention to the numbers of SCN in your lab reports, along with an analysis of field history, will tell you most of what you need to know about the success of your SCN management strategy. If your SCN numbers are rising when you plant a resistant variety – it is time to first switch to a nonhost and then to use soybean varieties derived from a different source of resistance after that.

Nonhosts must be included in the rotation to decrease the numbers of SCN and slow down its adaptation to resistant varieties.

9. How do I manage my soybean crop to minimize losses due to SCN?

The number of SCN in a field can be greatly reduced through proper management, but it is impossible to eliminate SCN from your field once it has become established. With currently available management options, it is much easier to keep low numbers low than it is to try and drive high SCN numbers down.

The goals of soybean management in the presence of SCN are to:

- Improve soybean health and yield
- Keep SCN numbers low
- Preserve the yield potential of resistant varieties

Because no single management practice will meet all three goals, you must use an integrated approach that combines several components. Chief among these practices are the use of resistant varieties and a properly designed crop rotation.

Resistant Soybean Varieties

Unlike susceptible varieties, resistant soybean varieties reduce the ability of SCN to develop and complete its life cycle. Resistant varieties vary in their levels of resistance. Resistance is not complete: SCN reproduction continues at a reduced rate. In general, the SCN reproduction on a resistant soybean variety will be less than 10 percent of what occurs on a susceptible variety. The use of resistant varieties allows you to grow soybeans profitably now, while managing SCN numbers so that soybeans can be grown profitably in the future.

In the recent past, farmers may have been reluctant to use resistant varieties because there was a yield gap between resistant and susceptible varieties in fields that were not infested with SCN. Because of the joint efforts of soybean breeders and nematologists, high-yielding SCN-resistant varieties are now available.

Several different sources of SCN resistance exist (see Table 1) and have been used to develop resistant soybean varieties. Most individual resistant varieties carry resistance from only one source. This may allow you to rotate sources of SCN resistance to help prevent the development of more damaging HG Types. Check with your land grant university and the seed companies with which you work for more information on sources of resistance in varieties adapted to your area.

Unfortunately, SCN-resistant varieties that yield comparably do not necessarily control the nematode equally. SCN-resistant varieties can vary considerably in how well they control nematode population densities, even top varieties. Greater SCN reproduction will result in a higher SCN population in the soil the next time soybeans are grown in that field.

Consequently, growers must consider how SCN-resistant soybean varieties affect SCN populations in addition to how well the varieties yield to maintain the long-term productivity of the field for soybean production. Selecting SCN-resistant varieties based solely on yield data is short-sighted and risky because some relatively high-yielding soybean varieties allow substantial amounts of SCN reproduction. Keep this point in mind when evaluating soybean variety trial data.

Crop Rotation

Crop rotation produces many benefits and should be part of your management program whether you have SCN or not. If you have SCN, your rotation should include nonhost crops and resistant soybean varieties. If you can successfully reduce SCN numbers, you may consider growing a susceptible soybean variety in the rotation for a single year, with the understanding that the number of SCN will increase. Be certain that SCN population densities are low before considering growing an SCN-susceptible soybean variety in the rotation. You should also avoid growing an SCN-susceptible soybean variety in an SCN-infested field, no matter what the SCN numbers are, if a drought is expected.

A good SCN management plan should not include other hosts for SCN (Table 2). Although soybean is the major host crop for SCN, the nematode has a wide host range. SCN levels have been increasing in edible bean production areas of the United States and Canada, and their inclusion in a rotation will increase SCN populations.

Table 2. Hosts for soybean cyst nematode.

Crop Plants	Weed Plants
Alsike clover	American and Carolina vetch
Bird's-foot trefoil	Common and mouse-ear chickweed
Common and hairy vetch	Common mullein
Cowpea	Field pennycress
Crimson clover	Hemp sesbania
Crownvetch	Henbit
Edible beans	Hop clovers
Lespedezas	Milk and wood vetch
Pea	Pokeweed
Sweet clover	Purple deadnettle
White and yellow lupine	Purslane
	Shepherd's purse
	Wild mustard

Nonhost crops

Nonhost crops (Table 3) cannot be used as a food source by SCN. In a field planted to a nonhost, SCN numbers will not increase and should decrease. When nonhosts are grown, juveniles will hatch from some of the eggs and will starve or be destroyed by natural

Table 3. Poor hosts and nonhosts for SCN management rotations.

Alfalfa	Melons	Sugarcane
Barley	Miscanthus	Sweet potato
Canola	Oats	Sweet sorghum
Corn	Peanuts	Switchgrass
Cotton	Red clover	Tobacco
Forage grasses	Rice	Tomato
Grain sorghum	Sugar beet	Wheat

enemies. The amount of decrease varies in relation to geographical area. SCN numbers may decrease by as much as 90 percent in the southern United States but only 10 to 40 percent in the north (some of the difference is due to poor winter survival in the South due to higher soil temperatures, which allows hatching).

Rotation design

Rotation design depends on conditions specific to your farm and individual fields as well as commodity prices and input costs. Success at reducing SCN numbers is clearly related to geographical region. Farmers in the northern Soybean Belt will observe slow reduction in SCN regardless of rotation design. In these areas, more frequent use of nonhost crops is appropriate. Several rotation sequences may be required before an appreciable drop in SCN is observed. Farmers in the southern United States usually observe a more rapid reduction in SCN numbers. A southern rotation may consist of alternating years of nonhosts and resistant soybean varieties. Double-cropped soybean after wheat should be considered a full year of soybean. SCN buildup in double-crop soybean may be less than in full season soybean, but a significant increase is just as likely to occur. Rotation designs have been thoroughly tested in many locations in the United States. Be sure to check with your local sources for specific recommendations useful to you.

The slower SCN numbers decrease, the more often you need to grow nonhost crops. To determine the effectiveness of your rotation, you must sample for SCN (see Section 6). If SCN numbers increase on resistant varieties, your source of resistance may no longer be effective and you should choose a variety with a different source of resistance or plant a nonhost.

Controlling winter annual weeds

Purple deadnettle, henbit and field pennycress are moderate to good hosts for SCN (Table 2). If these winter annual weeds are growing in SCN-infested fields and soil temperatures are greater than 50°F, SCN reproduction and increases in population densities can occur. (SCN cannot develop in roots below 50°F.)

The SCN life cycle takes 21 to 24 days to complete at ideal temperatures (76°F) and can take five or more weeks at colder temperatures. There may be periods of time in the spring or fall when soil temperatures are warm enough for SCN reproduction to occur on winter annual weeds.

Other Cultural Practices

Maintaining adequate soil fertility, breaking hardpans, irrigating (if possible), and controlling weeds, diseases and insects improve soybean plant health. These practices help plants compensate for damage by SCN, but do not decrease SCN numbers. These practices should be part of your rotation management, but cannot substitute for a properly designed rotation.

Nematicides

A few nematicides are available and labeled for use in managing SCN (labeling varies by state), but these compounds are seldom recommended. However, new seed treatments are being developed for SCN management, and these are being tested throughout the northern Soybean Belt for their efficacy. Check with local sources for further information on nematicide and seed treatment labeling and recommendations.

Factors that make nematicides an uncommon choice are:

- Resistant varieties are more cost effective
- Nematicides increase cost of production
- Nematicides frequently result in high SCN numbers at season's end
- Nematicides may adversely affect the environment

Biological Control

Natural enemies of SCN are found in most soils, and may even suppress SCN populations. Certain fungi, bacteria, and predaceous nematodes are known to destroy SCN, but they have been very difficult to develop into commercial products. Nonetheless, progress is being made in this area. Check with local sources for more information on SCN control biological agents as research progresses.

10. Recommendations for Managing SCN

Rotate, Rotate, Rotate, Rotate:

1. Rotate with nonhost crops to reduce SCN numbers.
2. Rotate with resistant soybean varieties to reduce yield loss due to SCN.
3. Rotate the resistant varieties you use: don't use the same one twice in a row.
4. Rotate with tolerant or susceptible soybean varieties only if SCN numbers are low.

Relieve Stress

Good management of weeds, water and soil fertility will avoid compounding damage due to SCN.

Other Practices

No-till, late planting or other practices may be beneficial. Check local recommendations.

Monitor SCN populations through periodic sampling and note how the numbers change. It is much easier to keep numbers low than it is to drive high number down.

SCN cannot be eliminated from an infested field, but soybean production can remain profitable with proper SCN management.

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