

Management of Soybean Cyst Nematode

Introduction

The soybean cyst nematode (*Heterodera glycines*) is the most significant nematode pest affecting soybeans on Delmarva and in the United States. First detected in Delaware in the fall of 1979, the soybean cyst nematode (SCN) was widespread in Sussex County. Although found in Kent County just a few years later, SCN was not discovered until 1991 in New Castle County in the southwest corner near Clayton. SCN, which is not restricted by soil type, can be found anywhere soybeans have been grown for a long time.

Symptoms

Symptoms of SCN infections range from no visible evidence of plant injury to yellowing and stunting, leading sometimes to plant death in certain areas of a field. Symptoms commonly associated with SCN damage are similar to other crop production problems, such as manganese deficiency, spider mite infestations, herbicide injury, potassium deficiency, low spots, drought stress and soil compaction. The only visible sign of SCN infection is the presence of white or yellow female cysts on the roots, but they might not be present at the time of sampling. Growers should look for these visible symptoms as well as other soybean production problems, including continuous soybean production, declining yields and weed control failures, all of which could indicate SCN.



Biology and Life Cycle

Like all plant parasitic nematodes, SCN is a microscopic roundworm. The second stage juvenile is the infective nematode, so-called because it molts once in the egg from first-stage to second-stage. Juveniles penetrate soybean roots and cause the formation of specialized feeding cells in the root's vascular system. These feeding sites divert materials needed for root growth to nourish the developing nematodes. These nurse cells also prevent nutrients from reaching the shoots and leaves of the plant; the resulting plant damage is primarily because of this feeding by females. Molting three more times before becoming adults, the SCN female juveniles lose their ability to move and swell to a lemon-shaped mature female. White females become yellow as they age and then brown when they die.

The brown stage is the cyst for which the nematode is named. Each cyst can contain up to 500 eggs, but under field conditions, they usually contain fewer. The cyst, which protects the eggs from the soil environment, overwinters, and egg hatch begins in the spring. If the emerging juvenile nematodes cannot find a host plant within several weeks, they die. When soybeans are planted, exudates from developing roots stimulate more hatching and attract juveniles to the root systems.

The females will generally mature in 21 to 28 days and begin to produce eggs. After 30 to 40 days, yellow and brown cysts can be seen on the roots. The number of eggs produced during a season can be influenced by the length of the growing season, which is related to the soybean maturity group and the environment during the growing season. A long-season variety will allow for more generations and more reproduction. Hot weather limits SCN reproduction. Soil temperatures above 90 degrees F shut down reproduction, while cool to moderate conditions with ample moisture increase reproduction. In seasons with adequate rainfall, infected soybeans without symptoms can lead to population increases that if not detected by soil sampling can be serious the following season.

The effect of SCN on soybean growth and yield involves several mechanisms that are directly related to the numbers of nematodes feeding on the root system: plant nutrients are removed, nutrient and water uptake in the roots are disrupted, and root growth is retarded. Plants that are infected with high numbers of SCN have poorly developed roots that cannot efficiently utilize nutrients and water available in the soil. The result is stunted plants, and often, yellow foliage. SCN infection also can reduce the number of nodules formed by the beneficial nitrogen-fixing bacteria that are necessary for optimum soybean growth. The nematode feeding also wounds the roots so that they can be invaded by secondary fungal pathogens such as *Rhizoctonia*, *Fusarium*, and *Pythium*.

Races of SCN

Field populations of SCN are genetically variable. In the early 1960s researchers found that geographically distinct populations of SCN varied in their ability to reproduce on resistant soybean cultivars or plant introductions (PIs). These PIs were soybean relatives from the Orient (China, Japan, Russia) where soybeans originated. In 1969 a group of nematologists and soybean breeders proposed calling these variable populations "races" based on a host test. The race differential soybean lines were two cultivars, Peking and Pickett, and two PIs 88788 and 90763. The cultivar Lee was recommended as the standard susceptible for race

determination tests. The original race scheme described only four races, but this was expanded in 1988 to include 16 races based on all the possible combinations of yes and no's on four differentials.

In Delaware, races 1,3, 5, 6, and 9 are known to occur. Race 3 is the most common (67 percent), followed by race 1 (28 percent), and races 5, 6, and 9 are less frequent (5 percent). Knowing the race of SCN can help growers in selecting resistant varieties for their farms. If a field has race 3, then a variety with resistance to race 3 and 14, or race 1 and 3, would provide the needed resistance. If a field has race 1, then a variety with race 1 and 3 resistance would be the best choice.

In Delaware specifically, race 1 populations have been quite variable; one population even shifted to a race 5 in one season. A race 1 population with a high reproductive index on PI88788 reduced the yield of race 3,14 resistant cultivars significantly while other race 1 populations with lower reproductive indices have not. Fortunately, these more pathogenic race 1 populations have been rare. The key is to choose a race 1,3 resistant variety if you know you have race 1. If you do not know the race, a race 1,3 resistant variety will cover 95 percent of the races that might be encountered. Unfortunately, not many race 1,3 resistant varieties exist, and they are mostly group V cultivars. The chief exception is Manokin, which is a late group IV. All group III's and most group IV and V cultivars have race 3 or race 3,14 resistance. Varieties with race 3,14 resistance often have low to moderate resistance to race 1, which is better than planting a susceptible variety. Under most conditions that level of resistance will be adequate to get acceptable yields. Most Round-Up Ready varieties do not have resistance to race 1. New varieties with Cyst-X background should do well in race 1 infested fields.

Management

SCN can be managed by several strategies including rotation with or without the use of resistant varieties. Management plans should aim to reduce SCN populations and promote soybean health.

Rotation: Crop rotation is beneficial for profitable soybean production and can significantly reduce SCN populations. Planting a non-host crop such as sorghum, corn, sunflower, or vegetables (except snapbeans) will reduce SCN populations. Small grains, although non-hosts, are not considered to be rotation crops since they are not growing when SCN is active. However, small grains can help reduce SCN populations, because the soybeans planted behind small grains usually are exposed to fewer SCN at planting and allow less time for SCN reproduction. SCN numbers in a field decline faster when the grower uses non-host crops instead of planting resistant varieties. Two or more years of using non-host crops and/or resistant varieties may be needed to reduce SCN populations to undetectable levels.

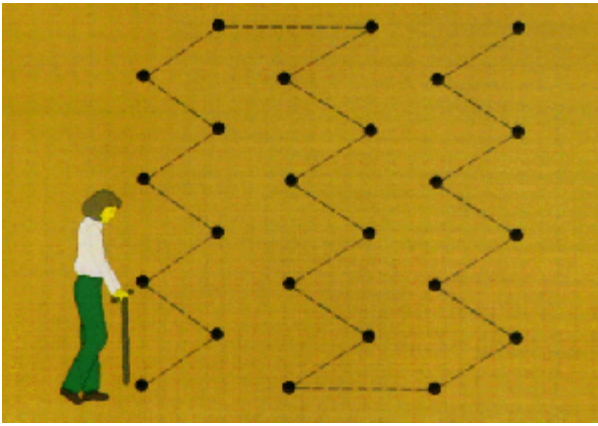
Never plant susceptible varieties without first taking a nematode soil test. Never presume that your control program has reduced the numbers to a safe level. If SCN is not detected or is at very low levels, susceptible varieties can be grown for one season. Planting susceptible varieties in rotation with non-hosts or resistant varieties can prevent race shifts. In the sandy soils of Sussex and Kent counties, planting susceptible varieties in an SCN-infested field may be possible once every three or four years.

Resistant varieties: Using resistant varieties is the most economical means of managing SCN. As mentioned before, resistant varieties should be chosen for their resistance to the specific SCN population in the field. Several races of the nematode are present in Delaware (see Races of SCN section). Race 3 predominates while race 1 is also present as are races 5, 6 and 9. Growers who use resistant varieties should alternate among varieties with different sources of resistance to SCN. Most commercial cultivars contain genes for resistance against race 3 and 14 (these will control race 9 also), while a few others have resistance to races 1 and 3. A few cultivars also have resistance to race 1, 3, and 5. Hartwig is resistant to all known races of SCN, but in many field tests has not yielded well. Most Round-Up Ready varieties have resistance to race 3 but not race 1. New varieties with the Cyst-X background have been reported to be resistant to all known races. As of 2003 these new Cyst-X varieties have not been tested in our state soybean variety testing program as far as we know. See Extension fact sheet PP-13 Soybean Variety Reactions to Soybean Cyst and Root Knot Nematodes, or check seed company sources for information on varieties and resistance. Exclusive use of resistant varieties is not recommended. Yearly monitoring of egg numbers is important to detect any shift in SCN races. If continuous resistant soybeans is selected as the major control measure, it is important to remember that resistant varieties are still attacked by the nematode. They are resistant because they prevent or limit nematode reproduction, but the nematodes can enter the root and cause damage. Some reproduction can occur. They will still yield better than a susceptible variety. So it is always recommended that resistant varieties be grown in a rotation with non-hosts and/or susceptible soybeans to reduce SCN populations and prevent race shifts.

Chemical control: Chemical control is not economically feasible nor as effective as rotation and planting resistant soybeans. For these reasons, chemicals are generally not recommended.

Soil Sampling

The best way to confirm an SCN infestation is to sample soil when symptoms are first seen. Or, if the white or yellow females are not observed, at the end of the season once the crop is harvested. The Nematode Assay Program provided by Delaware Cooperative Extension can provide this information. Soil sample bags for nematode assays are available for a small fee from county Extension offices. Fall is the best time for nematode sampling. Sample after fall harvest but before fall tillage. Take 20 to 30 soil cores between plants in the row of the harvested crop. Soil test bags and detailed nematode sampling instructions are available from the Extension office in each county.



Soil sampling pattern for survey sample after fall harvest.

In areas of the county known to have SCN infestations, do not plant susceptible varieties without first taking a nematode soil test. Fortunately, SCN can be found at any time of the year as long as the soil is not frozen, too wet, or too dry.

For fields known to be infested, monitor nematode numbers by taking nematode samples in the fall following harvest. Routine monitoring of SCN egg numbers can indicate the effectiveness of your management plan. This is very important when resistant varieties are used almost exclusively. Increases in egg numbers following a resistant variety could indicate that a different race is present.

SCN can be managed, but not eradicated.

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Caution : The information and recommendations in these fact sheets were developed for Delaware conditions and may not apply in other areas.