MANAGING NEMATODE PESTS IN MIDSOUTH SOYBEANS

Soybean producers in the Midsouth must contend with nematode pests, several species of which may inhabit a single field. Yield losses caused by soybean cyst nematode (SCN), southern root-knot nematode (RKN), and reniform nematode (RN) were estimated at over 35 million bushels in the Midsouth states in 2018. Of the three nematode species that affect soybeans, losses to RKN were greatest in Arkansas, Louisiana, and Mississippi, whereas losses to SCN were greatest in Missouri and Tennessee.

All three of the above nematodes feed on soybean roots. Populations can build up rapidly in the soil because females of all three nematode species produce large numbers of eggs in a relatively short period of time.

Damage caused by the nematodes as they feed results in symptoms such as:

- Stunting and yellowing of the foliage
- Stunted and discolored roots
- Roots infected by RKN may have swellings or galls
- Roots infected with SCN or RKN may have fewer nodules, which further limits soybean plant growth and yield by reducing the plant’s access to nitrogen.

Damage caused by RKN may include swellings or galls on roots. SCN and RN may reduce soybean yield by reducing the plant’s access to nitrogen.

Click here for a comprehensive scouting guide on this website. This reference provides details about common nematode pests of soybeans, guidance on sampling and scouting practices, and information that will help identify and treat nematode problems that occur in Midsouth soybean fields.

The change in cropping systems in the Midsouth in recent years has led to increased concerns about nematode infestations of soybeans. The effect of these changes is:

- Increased acreage of corn that may be rotated with soybeans has led to heightened concern about soybeans being infested with RKN.
- Growing soybeans on sites once devoted to cotton has led to heightened concern about soybeans being infested with RN.

Because of these cropping system changes, the need to sample for nematodes has become even more important.

**SAMPLING**

- Properly collected and evaluated soil samples are the best tool for detecting the presence and species of nematodes in the soil.
- To assess potential damage from nematodes in soybean fields, growers must determine which nematode or nematodes are present to make appropriate nematode management decisions.
- Accurate identification of the nematode species and population levels present in a field requires that soil samples be collected and sent to a diagnostic lab for evaluation.
- Properly analyzed samples will indicate where control practices are not needed, and conversely will indicate where control practices are needed to protect yield potential.
- Predictive sampling (sampling to determine if nematode problems are likely to affect a future crop) should be done when population densities are high in order to decrease the risk of not detecting the presence of a damaging species. Thus, the best time to sample is generally near or just after harvest. Sampling in the fall will allow enough time for analysis so that results can be used as a guide for variety selection or choosing an alternative crop for the next growing season.
- Proper sampling protocol can be found at MSU-ES and Virginia Tech Extension.

Mississippi soybean producers may submit soil samples for nematode analysis to the Mississippi State
University Extension Plant Pathology Lab. Instructions for sample submission and associated costs are contained in their post. Click here for a nematode sample submission form.

- If test results indicate that the above nematode species are not present in a field, care should be taken to prevent their introduction since nematodes can be moved from field to field by soil that is transported on field equipment.
- If test results indicate the presence of nematodes, the management goal is to keep the nematode population as low as possible since they are very difficult to eliminate. This involves using management practices presented below for each nematode.
- Crop production practices that provide adequate nutrients and water and minimize stress due to insects, weeds, and diseases will enhance soybeans’ ability to withstand some nematode feeding damage, but will not prevent yield loss where infestations are severe.

Sampling for nematodes should be considered as important as sampling for soil fertility. This is especially true if there is no history of nematode sampling on either old or new soybean production sites. Once documentation of the absence or presence of nematodes is established for given fields, then management options outlined below can be adopted.

**SOYBEAN CYST NEMATODE (SCN)**

SCN is one of the most damaging pests to soybean in the Midsouthern US. It is found in an increasing number of fields each year. The biggest challenge facing producers with SCN is that this soil-borne pathogen can impact yield with no or few visible aboveground symptoms. Management options and their implications are:

- Determination of the density and race or HG type of SCN present in individual fields is required to prevent losses and determine management and control practices to apply. Determination of the race or type is especially important because the different SCN resistance sources convey differing levels of resistance against the varied races or types (Rotundo et al., Crop Science).
- Use of SCN-resistant varieties is the best tactic to prevent yield-reducing damage from SCN (Giesler and Wilson, Univ. of Nebraska; Niblack and Tylka, NCSRP; Wrather and Mitchum, Univ. of Missouri; Chen, Agronomy Journal). Ratings of SCN resistance in current varieties are available in the disease ratings section of the most recent Arkansas Soybean Variety Trial results and in the soybean characteristics section of the Tennessee Soybean Variety Trial results.
- Use of SCN-resistant varieties does not compromise yield potential compared to using SCN-susceptible varieties (De Bruin and Pedersen (1), Agronomy Journal; DeBruin and Pedersen (2), Agronomy Journal).
- Soil texture affects movement of SCN in the soil and also may affect its reproduction and development. Basically, major damage to soybean by SCN infestation occurs when the crop is grown on medium- and coarse-textured soils. Apparently, damaging populations of SCN are not sustainable in soils series classified as clay (Heatherly and Young, Crop Science; Young and Heatherly, Journal of Nematology).
- In the Midwest, the yield advantage from using resistant vs. susceptible varieties is more pronounced in high-pH (>7.0) soils (Pedersen et al., Crop Science). The pH of soils has the same meaning regardless of region; however, this relationship has not been confirmed in southern environments. Thus, the possibility of this relationship occurring should at least be considered when growing soybeans on high-pH soils in northeast Mississippi and the Midsouth.
- A variety with resistance to a specific population of a race of SCN should not be planted year after year because SCN adapts to varieties, especially those that have resistance derived from the same source such as PI 88788. Continuous planting of such a variety could lead to the development of a different SCN race that damages the crop, making that variety useless for SCN control (Young, Journal of Nematology; Niblack et al., Plant Health Progress). In fact, results reported by McCarville et al. (PHP 2017) found that occurrence after analyzing results from 15 years of field experiments in Iowa. They concluded that the effectiveness of PI 88788 SCN...
resistance as a management practice will continue to diminish if new sources of resistance do not become widely available in the near-term. See the below Apr. 2020 Update for recent developments that will mitigate the issue of SCN adaptation to varieties with a single source of resistance.

• Crop rotation is an effective tool for managing SCN. Nonhost crops such as corn, cotton, grain sorghum, and rice successfully reduce SCN populations (Young, Plant Disease Journal).

• It is important to determine the race of SCN in a field and the race-specificity of the resistance gene of a previously planted soybean variety when planning to use a new resistant variety in a crop rotation system for SCN management. The originator of a soybean variety should furnish information about the race-specific resistance of that variety. Varieties with resistance to SCN are available in all MGs.

• Irrigation of soybeans does not affect varietal response to infection by SCN, the capability of SCN to maintain cysts on any variety, or the yield-limiting effect of SCN on susceptible varieties. Irrigation may increase yield of susceptible varieties grown on SCN-infested fields, but often yields will be less than those from irrigated susceptible varieties grown on non-infested fields as well as those from irrigated resistant varieties grown on infested fields. Thus, irrigation of SCN-susceptible varieties grown on infested fields should not be considered since irrigation efficiency (amount of yield increase per unit of applied water) will be low and subsequent yields may be unprofitable (Heatherly et al., Crop Science).

• Resistant varieties are more reliable and cost-effective than nematicides for managing and/or reducing SCN populations (Wrather and Mitchum, Univ. of Missouri).

• In areas with severe infestations, soybean production without control measures is not economically feasible. Conversely, soybean production can be profitable with proper SCN management.

• Excellent sources for SCN management guidelines are Giesler and Wilson, Univ. of Nebraska; Niblack and Tylka, NCSRP; Wrather and Mitchum, Univ. of Missouri, and SCN Field Guide, Iowa State Univ (2012). Also, a multi-state initiative funded by the Soybean Checkoff Program called the The SCN Coalition began recently to promote awareness of the damage caused by SCN, the importance of managing this pest, and recommended practices to thwart its spread and effect. This website will be kept up to date with new information about SCN management as it becomes available.

• A PMN webcast titled “Soybean Cyst Nematode Management” by Dr. George W. Bird of Michigan State University provides great information about SCN topics that include: SCN biology and host-plant relationships; symptoms and problem identification, diagnosis, and confirmation; SCN management practices; SCN type test vs. the currently-used race system; and seed treatments that include both chemical and biological controls.

• As stated above, a variety with resistance to a specific population of a race of SCN should not be planted year after year because SCN adapts to resistant varieties. Continuous planting of such a variety could lead to the development of a different SCN race that damages the crop, making that variety useless for SCN control. The HG Type Test is an excellent tool for determining if SCN-resistant varieties with the same source of resistance that have been grown for an extended period in the same field have resulted in the selection of the SCN population in that field against the resistance acquired from PI 88788, the most-used resistance source. This is why merely changing varieties for a given field that is infested with SCN will be ineffective if these different varieties all have SCN resistance acquired from the same source. This could explain why soybean growers may be seeing declining performance from SCN-resistant varieties in SCN-infested fields (UNL Cropwatch, Sept. 19, 2018). Click here for a detailed presentation about using the HG Type Test to determine if varieties grown on an SCN-infested field should be selected based on a different source of SCN resistance.

Using HG Type to Select SCN-resistant Soybean Varieties

Choosing soybean varieties with genetic resistance (or host plant resistance) to SCN has long been a major economical defense against this pest, and breeders/geneticists have continued to thwart the
negative effects of SCN by releasing new soybean varieties with resistance to evolving types of this pest. The long-term effectiveness of genetic resistance to SCN is documented in a paper (Rincker et al., Crop Sci., Jan. 2017) entitled “Impact of Soybean Cyst Nematode Resistance on Soybean Yield”. This presentation uses results from 11 years of yield tests that were conducted over 1,247 test-environment combinations in the north-central US and Canada.

Populations of SCN in soybean fields exhibit diversity in their ability to develop on resistant soybean varieties, and this variation has implications for management strategies that can be used to mitigate SCN damage. Since 1970, this diversity has been characterized by assigning a race designation to an SCN population in a given field. According to Dr. Terry Niblack et al. (J. of Nematology, Dec. 2002, “A revised classification scheme for genetically diverse populations of H. glycines”), an HG Type test better describes how a field population of H. glycines will affect a soybean variety that is planted in a given field that is infested with SCN. The authors further state that the HG Type test 1) can serve as a mechanism for classifying differences among field populations of nematodes or population changes over time, 2) can be used by nematologists and breeders to develop resistant soybean varieties and to describe nematode populations used for screening, and 3) can be used to develop management recommendations for producers.

The HG Type test uses seven indicator lines that have been used as sources of resistance for developing SCN-resistant soybean varieties, and a susceptible check. They are:

- PI 548402 (Peking) HG Type 1
- PI 88788 HG Type 2
- PI 90763 HG Type 3
- PI 437654 HG Type 4
- PI 209332 HG Type 5
- PI 89772 HG Type 6
- PI 548316 (Cloud) HG Type 7
- Lee 74 used as standard susceptible genotype.

In this test, the variable Female Index (FI = [mean number of SCN females on a soybean line being tested divided by mean number of females on the standard susceptible] x 100) is the value used to assign HG Type to a field population of SCN. A cutoff number of 10 (10%) was chosen for FI because it is assumed that populations with FI’s less than 10 would not maintain themselves in the confines of a single growing season.

**Results from an HG Type test must show the FI value along with the HG Type designation to avoid the inference that all populations with the same HG Type are equivalent.**

According to Dr. Heather Kelly of the Univ. of Tennessee (utcrops.com Nov. 2018), “The scientific definition of a resistant variety (there is no legal definition in the US) is that a resistant variety should allow less than 10% reproduction relative to a susceptible variety (in other words, there should be 90% suppression or control). So the tool we have to test if an SCN population can reproduce more than 10% (relative to a susceptible variety) on any of the 7 main sources of resistance is called the HG Type test.” The HG Type test replaces or should replace the SCN race test for determining or predicting SCN reproduction potential on resistant soybean varieties.

In a properly conducted HG Type test, a replicated set of indicator lines (those shown above) and the standard susceptible, Lee 74, are infested with equal numbers of H. glycines eggs taken from a field population of the nematode. After 30 days, the females that have developed on soybean roots are extracted from the soil, counted, and used to calculate an FI. Any indicator line with an FI ≥ 10 is considered a suitable host for the tested SCN population.

The result from the HG Type test is simply a list of the numbers from the above list of indicator lines that correspond to being suitable hosts. For example, HG Type 1.2.6 means that PI 548402 (Peking–HG Type 1), PI 88788 (HG Type 2), and PI 89772 (HG Type 6) had FI’s ≥ 10 and therefore are considered suitable hosts for SCN development. An HG Type 0 means that the nematode sample did not produce an FI ≥ 10 on any of the indicator lines.

The above-cited article provides great detail for conducting the HG Type test, including sampling protocol, source of seed for the indicator lines and
susceptible variety, proper mixing of the field nematode sample, experimental design and growing conditions, and data collection.

The bottom line from HG Type test results follows.

If any of the seven indicator lines shown above produce an FI ≥ 10 from the nematode sample, then varieties with that source of resistance against SCN should not be used in the sampled field. Conversely, if the nematode population produces an FI < 10 on all the indicator lines, then any variety can be planted in the sampled field without regard for SCN resistance. It is important to remember that the HG Type designations resulting from the test are population descriptions and not genotypes of individual nematodes; i.e., the HG Type designation describes the SCN population in a field and not any one SCN individual, and indicates the relative ability of the overall SCN population in the field (represented by the sample) to reproduce on the HG indicator soybean lines.

Drs. Greg Tylka and Terry Niblack provide an example (Tylka and Niblack, NCSRP) of how the HG Type Test is used to determine the SCN population in a field.

In the above example, the number of females on the roots of PI 88788 (FI = 29) and Cloud (FI = 11) exceed 10% of the number of females on Lee 74. Thus, the nematode population in this field is classified as HG Type 2.7 and the producer should consider growing an SCN-resistant variety that obtained its resistance from a source other than PI 88788 or Cloud (See below Apr. 2020 update for recent developments to address this issue). Note that the number of females on PI 88788 and Cloud are quite different. This confirms the importance of showing the FI value along with the HG Type designation to avoid the inference that all populations with the same HG Type are equivalent. Also, another SCN population could have twice the number of females on the same two indicator lines shown above (i.e., 146 and 56), but would still be classified as HG Type 2.7. However, the virulence of the population would be much greater on both indicator lines in the latter case.

Click here (Tylka, Plant Health Progress, June 2016) and here (Tylka, Iowa State Univ., Nov. 2006) for Dr. Tylka’s publications that provide additional information on using the HG Type test to develop, implement, and monitor an SCN management plan using SCN-resistant varieties.

The HG Type test for SCN populations has become increasingly important because almost all SCN-resistant soybean varieties have SCN resistance genes from PI 88788. According to Dr. Niblack (Plant Health Progress, Jan. 2008), a significant portion of SCN populations in Illinois have adapted to PI 88788 to some degree, which in effect reduces the effectiveness of SCN-resistant varieties with this source of resistance. It is likely that this adaptation of SCN to PI 88788-derived resistance has/is occurring in other US soybean producing areas that have relied on this source of resistance for the development of SCN-resistant varieties. See the below Apr. 2020 Update for recent developments that will mitigate the issue of SCN adaptation to varieties with a single source of resistance.

Thus, the HG Type test is made to order to determine if...
SCN-resistant varieties that have been grown for an extended period in the same field have resulted in the selection of the SCN population in that field against the resistance acquired from PI 88788. This is why merely changing varieties for a given field that is infested with SCN will be ineffective if these different varieties all have SCN resistance acquired from the same source—e.g. PI 88788. This could explain why soybean growers may be seeing declining performance from SCN-resistant varieties in SCN-infested fields.

Dr. Niblack proposes short- and long-term solutions to this problem where it exists. In the short term, use varieties with resistance acquired from sources other than PI 88788 (See the below Apr. 2020 Update). For the long term, rotate varieties with different SCN-resistance sources in order to slow SCN’s adaptation to resistance and preserve the effectiveness of SCN-resistance sources.

ROOT-KNOT NEMATODE (RKN)

RKN tends to be associated with sandy soils on sites that have previously been devoted to cotton production in the Midsouth, where the combination of root damage and the reduced water-holding capacity of the soil can result in wilting of infected plants during the heat of the day.

- Management of RKN by crop rotation is complicated by the wide range of hosts for the nematode (see below table). This is especially true for Midsouth producers where the common rotational crops are corn, cotton, and wheat, which all serve as hosts for RKN. Thus rotation of soybeans with these crops is not a management option for this nematode.
- Rotation of soybeans with flood-irrigated rice or grain sorghum will lower RKN numbers dramatically (Kirkpatrick and Thomas, University of Arkansas).
- The use of resistant varieties is the most effective tool for management of RKN; however, the number of current varieties that are resistant to colonization is low. Using varieties that are only moderately resistant will allow RKN populations to be maintained or increased (Kirkpatrick and Thomas, University of Arkansas). Ratings for selected soybean varieties in a southern RKN infested environment can be found here.
- Resistance to RKN is more prevalent in MG 6 through MG 8 varieties than in MG 5 and earlier varieties. Wide-spread use of MG 4 and earlier varieties in the Midsouth points to the need for RKN resistance in earlier-maturing varieties.

RENIFORM NEMATODE (RN)

This nematode will infect soybeans, but has not been a major threat to Midsouth soybean production.

- Where RN is a threat to soybeans, use resistant varieties as an effective management tactic, especially since breakdown of resistance has not been reported. RN ratings for current varieties in 2016 can be viewed in the file linked here. In 2017 and beyond, no Midsouth state made RN resistance ratings for soybean varieties.
- A biennial rotation of soybeans with corn, rice, grain sorghum, or wheat, which are poor hosts for RN, is an effective management tactic.
- Rotation of soybeans with cotton, which is an excellent host for RN, should not be done on infested fields (Kirkpatrick and Thomas, University of Arkansas).

NEMATICIDES

Nematicides applied to seed or used in-furrow can reduce early-season root infection by nematodes, but do not provide season-long control and may not be economical. Nematicides can be effective in controlling SCN populations in infested fields, but their use should be based on expected yield and subsequent income. Their use in low-yield environments may not result in yields that are sufficient to be profitable.

Nematicide products are available.

Votivo is a biological seed treatment that provides early-season protection against the above three nematode species. Poncho/Votivo is a combination insecticide/nematicide that is applied to the seed prior to planting. Little is known about the effectiveness of this nematicide in situations with known populations of nematodes. Therefore, at this time there is no
supposition that it will replace the accepted practices for nematode control and/or management.

**Avicta Complete Beans** is a seed treatment product that combines a nematicide (*Avicta 500FS*) with a fungicide (*ApronMaxx*) and insecticide (*Cruiser 5FS*). As with the above product, little is known about the effectiveness of this nematicide in situations with known populations of nematodes. Therefore, there is the same supposition as above regarding its use in lieu of the accepted practices for nematode control and/or management.

**Clariva Elite Beans** seed treatment is to be used as an on-seed application of separately registered products that has the added nematicide component for control of soybean cyst nematode (SCN). The nematicide component is in addition to the insecticide and fungicide components found in *CruiserMaxx Beans with Vibrance*. The nematicide component only targets SCN and not other nematode species.

The following four links provide detail about this product from Syngenta, the company that developed and is marketing Clariva.

- [Syngenta Description](#)
- [Syngenta Technical Overview](#)
- [Syngenta Power Point Presentation](#)

Available information indicates the cost of the nematicide component will increase the seed treatment cost to about $8 to $10 per acre above that for the product without the nematicide.

A Plant Management Network webcast titled “Evaluation of Seed-Applied Nematicide on Soybeans” presents the first year’s (2014) results from evaluating the effect of Clariva on SCN across the state of Iowa. These first-year results indicate that Clariva does inhibit SCN’s ability to reproduce, but the long-term effect of this reduction on soybean performance can only be determined with additional years of research.

At this time, little is known about the effectiveness of the above nematicides in situations with known populations of nematodes.
- A new soybean variety with resistance to SCN derived from PI 89772 is being released by Syngenta in small quantities for 2020.
- This represents an SCN-resistant variety that was developed from a breeding line other than PI 88788 and Peking.
- The trait originated in soybean germplasm from USDA that was collected in China 90 years ago.
- After nearly 25 years of work, the variety is being released under two brand names: Golden Harvest GH2329X and NK Brand S23-G5X. It is a MG 2.3.
- According to Syngenta, the variety has good tolerance to SDS and Phytophthora, and contains the RR2X herbicide technology trait.
- Research has shown that this variety, when grown in the presence of an SCN population that is highly virulent on PI 88788, resulted in a significant drop in that SCN population.
- This new resistance trait was initially bred into conventional soybean lines before transitioning to the RR2X trait.

Of course, this is a real positive for the soybean industry. However, for it to be useable by Midsouth soybean producers, it must be bred into later MG varieties that have all available herbicide tolerant traits. Hopefully, that transition will occur in the near future since there is an ongoing and effective collaborative effort among the SCN coalition’s university and industry partners.
Management/control options for three economically important nematodes affecting Mississippi soybeans.

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<th>Nematode</th>
<th>Management/control tactic</th>
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| SCN      | **Use resistant varieties***. Nematode populations, referred to as “races” or “HG types”, vary in their ability to overcome certain sources of resistance.  
**Crop rotation.** Rotate with nonhost or poor host crops such as corn, cotton, grain sorghum, peanuts, rice, and wheat. Do not rotate with other host crops such as common vetch, lapespeza, and snap bean.  
**Variety rotation.** A variety with resistance to a specific population of a race or type of SCN should not be planted year after year; i.e., rotate to varieties with genetic resistance from a source other than PI 88788, which is the major source of resistance in current SCN-resistant varieties. See above section on using HG Type to select resistant soybean varieties.  
**Seed treatment.** Never use a nematicide seed treatment product instead of using a resistant variety; rather, use it on a resistant variety ([UNL Cropwatch, Sept. 19, 2018](https://www.unl.edu/cropwatch)).  
**Control host weeds.** Common host weeds include but are not limited to common chickweed, common purslane, coffee weed, hemp sesbania, mouse-eared chickweed, mullein, pokeweed, sikelepod, and wild geranium. Click [here](https://www.mssoy.org) for a complete SCN Field/Management Guide from Iowa State Univ. |
| RKN      | **Use resistant varieties***. Click [here](https://www.mssoy.org) to access Univ. of Ark. variety performance ratings.  
**Crop rotation.** Rotate with nonhost or poor host crops such as peanuts and vetch. Do not rotate with other host crops such as alfalfa, corn, cotton, sweet potato, and wheat.  
**Control host weeds.** Common host weeds include but are not limited to annual morning glory, barnyardgrass, black nightshade, chickweed, crabgrass, dandelion, horseweed, lambsquarter, Pennsylvania smartweed, pokeweed, purple nutseedge, redroot pigweed, sikelepod, spiny pigweed, spurge, tall ironweed, and yellow nutseedge. |
| RN       | **Use resistant varieties***.  
**Crop rotation.** Rotate with nonhost or poor host crops such as corn, grain sorghum, peanuts, rice, and wheat. Often, two years of the nonhost crop is needed to effectively reduce RN population. Do not rotate with other host crops such as cotton, cowpea, vetch, snap bean, and sweet potato.  
**Control host weeds.** Common host weeds include but are not limited to annual sow thistle, beggarweed, black nightshade, cocklebur, coffee weed, crotalaria, hairy vetch, sikelepod, spurred anoda, and purslane. |

*Information about resistance in current varieties is available from the [Arkansas](https://www.ars.usda.gov) and [Tennessee](https://www.tennessee.gov) Variety Trial Publications, Extension specialists, seed dealers, and originating seed companies. Univ. of Ark. ratings of field performance of selected soybean varieties against root knot nematode can be accessed [here](https://www.mssoy.org).*

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