MANAGING NEMATODES 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 to be almost 23 million bushels in Arkansas, Louisiana, Mississippi, Missouri, and Tennessee in 2022. Of the three major nematode species that affect soybeans in the Midsouth, losses to RKN were greatest in Ark., La., and Miss., whereas losses to SCN were greatest in Mo. and Tenn.

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 soybean foliage
- Stunted and discolored soybean 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.

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.

SAMPLING

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 for the pests, and information that will help identify and treat nematode problems that occur in Midsouth soybean fields.

Because of the above-mentioned changes in cropping systems, the need to sample for nematodes has become even more important due to the added risk of infestations from RKN and RN as well as SCN. Consider the below points.

- 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 species are present to make appropriate nematode management decisions.
- Accurate identification of the nematode species and its population level 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 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.
- Sampling in the spring [Tonneson, Dakota Farmer, Mar. 2018] should still be done if sampling was not accomplished in the fall. This is especially important in fields or portions of fields 1) that may have flooded during the winter, 2) that had significant waterfowl activity during the offseason, 3) that are known to have high pH, or 4) that had stunted areas that produced low yields during the last soybean growing season.
- Proper sampling protocol can be found here and here.
- Mississippi soybean producers may submit soil samples for nematode analysis to the Miss. State Univ. Extension Plant Pathology Lab. Instructions for sample submission and associated costs are contained in their post.
- If test results indicate that 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 a species of nematode, the management goal is to keep the population as low as possible since all of the species are very difficult to eliminate. This involves using appropriate management practices for each species of nematode.
- Crop production practices that provide adequate nutrients and water and minimize crop 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 can be adopted.

SOYBEAN CYST NEMATODE [SCN]

SCN is found in all soybean-producing counties in the midsouthern U.S., and continually ranks as a significant damaging pest to soybean. 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 follow.

- 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 is available in individual company's variety trait data.
- 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 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 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 that have the same source of resistance 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] confirmed this 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]. However, a one-year rotation with a non-host crop will not remove SCN from the soil since SCN eggs can remain unhatched in the cyst for years.

- A doublecrop system of soybean followed by wheat is not considered an effective rotation for managing SCN populations. Recommended crop rotation sequences for managing SCN infestations can be found here and in the table below.
- 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.
- The originator of a soybean variety should furnish information about the race-specific resistance source used for a 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 yields will likely 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; SCN Field Guide, Iowa State Univ [2012], and a multi-state initiative funded by the Soybean Checkoff called the The SCN Coalition (see Nov. 2020 update at end of article).
- A PMN webcast titled "Soybean Cyst Nematode Management" by Dr. George W. Bird of Michigan State University provides information about SCN topics that include 1) SCN biology and host-plant relationships, 2) symptoms and problem identification, diagnosis, and confirmation, 3) SCN management practices, 4) SCN type test vs. the currently-used race system, and 5) 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 U.S. 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 previously] and the standard susceptible, Lee 74, are infested with equal numbers of *H. glycine* 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 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 in the Journal of Nematology 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 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.

Lee 74 [susceptible check]	250 females; **10% = 25**
Peking [indicator line 1]	17 females; **17/250 = 7 FI**
PI 88788 [indicator line 2]	73 females; **73/250 = 29 FI**
PI 90763 [indicator line 3]	3 females; **3/250 = 1 FI**
PI 437654 [indicator line 4]	19 females; **19/250 = 8 FI**
PI 209332 [indicator line 5]	9 females; **9/250 = 4 FI**
PI 89772 [indicator line 5]	16 females; **16/250 = 6 FI**
Cloud [indicator line 7]	28 females; **28/250 = 11 FI**

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.

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.

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)

Recent surveys indicate that the southern root-knot nematode is the most yield limiting nematode in

Arkansas, Louisiana, and Mississippi soybeans. 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 of corn, cotton, and wheat 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. Researchers at the Univ. of Arkansas annually conduct trials that include commercially available soybean varieties that are marketed for use on soils infested with RKN. Results from those trials can be accessed in the Arkansas Soybean Variety Trial data. These ratings were made on varieties grown in a field that had a known high population density of RKN.
- Using varieties that are only moderately resistant will allow RKN populations to be maintained or increased [Kirkpatrick and Thomas, University of Arkansas].
- Resistance to RKN is more prevalent in MG 6-8 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.
- Click here for an article that provides results from research that indicates that genetic resistance can protect soybean yield from loss caused by RKN when the crop is grown on sites that are infested with this nematode pest.
- A first line of defense against the RKN is knowing where it is so that preemptive action can be taken against it if/when necessary. Dr. Travis Faske, a plant pathologist at the Univ. of Arkansas, has played a major role in the development of a map that shows where RKN has been found. [Click here to access the map]. The map will tell soybean producers whether or not they should be on the lookout for the RKN in a field planned for soybeans. A Progressive Farmer/DTN article titled "Southern Root-Knot Nematode Mapped" by Pamela Smith [with quotes from Dr. Faske] will aid producers in choosing control measures that will be necessary if this nematode pest is expected to be a threat to a planned soybean crop.

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 varieties in 2016 can be viewed 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 [all 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. Click here to access a table of "Nematode-Protectant Seed Treatments", and here to access an article titled "Consider a Nematode-Protectant Seed Treatment to Shield Roots Against SCN". Both resources are provided by the SCN Coalition.

Combination products that contain nematicides are also available as seed treatments.

- Poncho/Votivo is a combination insecticide and nematicide that is applied to the seed prior to planting.
- Avicta Complete Beans is a seed treatment product that combines a nematicide [Avicta 500FS] with a fungicide [ApronMaxx] and insecticide [Cruiser 5FS].
- Clariva Elite Beans seed treatment is to be used as an on-seed application of separately registered products that has an added nematicide component. The nematicide component is in addition to the insecticide and fungicide components found in CruiserMaxx Vibrance, and only targets SCN.

There is no supposition that any of the above namaticide products will replace the accepted practices for nematode control and/or management. In fact, they should be used in combination with the accepted practices specified in this article. **According to information in UNL Cropwatch [Sept. 19, 2018], never use a nematicide seed treatment product instead of using a resistant variety; rather, use it on a resistant variety.**

APR. 2020 UPDATE

As stated above, SCN resistance in current soybean varieties has been derived almost exclusively from PI 88788. In fact, it is estimated that greater than 95% of current soybean varieties that are touted as resistant to SCN have that resistance derived from this one PI. As shown above, this resistance source has become less effective/durable because of the over-reliance on it for developing SCN-resistant soybean varieties.

Information contained in an article from the SCN Coalition provides a glimmer of hope for overcoming this problem. The major points in that article follow.

- 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.

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 tolerance 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.

NOV. 2020 UPDATE

A multi-state initiative funded by the Soybean Checkoff Program called the The SCN Coalition recently began promoting awareness of the damage caused by SCN, the importance of managing this pest, and recommended practices to thwart its spread and effect. The site has a map that can be used to access contact information for nematology experts in each soybean-producing state as well as resources that can be accessed to find out how to prevent SCN damage and/or control its spread. This website will be kept up to date with new information about SCN management as it becomes available. Thus, it will be the preferred resource for all SCN information because it will continually be updated as new information about nematode pests becomes available. Links to resources available on this authoritative website can be accessed from the home page.

Dr. Travis Faske, Extension Plant Pathologist for the Univ. of Arkansas, has produced a series of videos geared toward Arkansas growers. Issues surrounding the increasing threat posed by the RKN in southern soybean fields are highlighted. Click here for the video series.

MAY 2022 UPDATE

The Insecticide Resistance Action Committee of CropLife America has published a Nematicide MOA Classification Scheme that can be accessed here. This scheme [first edition, Version 2.1] enables visibility of the modes of action that are available to control plant-parasitic nematodes. The contents of the publication include a list of nematicide active ingredients along with their MOA classification using this scheme.

JULY 2022 UPDATE

An article titled "Long-Term tillage management affects claypan soil properties and soybean cyst nematode" by Belknap, Nelson, and Singh was published in June 2022 in Agron. J. This article contains results from long-term research that was conducted in northeast Missouri. Pertinent SCN information from that article follows.

- A long-term (1994-2016) cropping systems study was established in 1994 near Novelty, Missouri [approx. 40 deg. N lat.].
- Three rotational cropping systems were grown in three tillage systems [no-till corn-wheat-soybean (NTDCS), no-till corn-wheat-soybean with a red clover cover crop (NTFSC), and reduced-till corn-wheat-soybean (RT)] on a site with silt loam soil each year.
- Soil samples were analyzed for SCN eggs prior to planting each crop from 2002-2015. In 2002, no SCN eggs were present in the soil at the study site.
- In 2015 [last year of SCN tests], the HG Type of the SCN was determined to be 1.2.4.
- A longer rotation period between soybean plantings with NTFSC maintained low average SCN egg densities prior to planting soybean.
- Combined over 13 years [2002-2015] of data, SCN egg densities were lowest in NTFSC prior to planting all crops.
- The NTFSC cover crop system maintained SCN egg densities that were 79 to 97% lower than in the NTDCS and RT treatments, respectively, which indicates the long-term benefit of including a cover crop in these cropping systems. The differences were especially apparent in the later years of the study.
- The authors concluded from their results that it takes long-term research to adequately evaluate the profound impact that tillage management and cropping systems have on reducing SCN egg density.
- Producers are reminded to choose a cover crop species that is not a host for either RKN or RN.

APRIL 2025 UPDATE

According to recent surveys, SCN is a serious pest affecting soybeans in the upper portion of the midsouthern U.S. As mentioned throughout this White Paper and shown in the below table, current control methods have centered on using seed of resistant soybean varieties and crop rotation. However, the majority of current SCN-resistant varieties use PI 88788 as the resistance source, and SCN populations are rapidly adapting to overcome this source of resistance. Thus, new control methods in addition to use of different sources of resistance [such as that from Peking] must be identified and brought to market in order to thwart the adverse effect of SCN populations on soybeans. Below is a compilation of some recent developments that may improve soybean's ability to thwart the effects of SCN.

In an article titled New SCN control methods may boost future yields, author Tom Bechman provides a list of efforts that could lead to producers' enhanced management of SCN. They include

- BASF's Nemasphere biotech resistance trait [click here to access a BASF News Release about this] that uses a Cry14 protein that interferes with nutrient uptake in the intestines of the nematode. BASF anticipates the availability of this transgenic trait in 2028, pending regulatory approval.
- Teams headed by Dr. Melissa Mitchum at the Univ. of Georgia and Dr. Andrew Scaboo at the Univ. of Missouri have discovered a gene in PI 90763 and PI 437654 that is not found in Peking resistance. It is hoped that this gene can help combat the virulent SCN population that attacks Peking and will eventually lead to the development of varieties with better SCN resistance.

A research report titled Immunolocalization and Ultrastructure Show Ingestion of Cry Protein Expressed in *Glycine max* by *Heterodera glycines* and Its Mode of Action provides details about how a team of scientists led by Dr. R. Howard Berg developed a way to genetically equip soybean with the Cry14 protein. This approach will allow the soybean plant to successfully prevent SCN from feeding on its roots. The research conducted by the team further demonstrated that combining Cry14 with current treatment options reduces the SCN population on soybean roots, and confirmed the expected mode of action of the Cry protein.

Management/control options for three economically important nematodes affecting Mississippi soybeans.	
Nematode	**Management/control tactic**
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 non-host crops such as corn, cotton, grain sorghum, peanuts, and rice. Doublecropping of soybean and wheat is not considered a rotation to a non-host crop even though wheat is a non-host for SCN. Do not rotate with other host crops such as common vetch, lespedeza, 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]. **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, sicklepod, and wild geranium. Click here for an SCN Field/Management Guide from Iowa State Univ. and here for a 2020 Presentation titled "Managing SCN–2020 and Beyond" from the SCN Coalition.
RKN	**Use resistant varieties***. Click here 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 nutsedge, redroot pigweed, sicklepod, spiny pigweed, spurge, tall ironweed, and yellow nutsedge. Click here for a video collection that covers RKN issues in southern soybean fields.
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, sicklepod, spurred anoda, and purslane.
*Information about resistance in current varieties is available from the Arkansas and Tennessee Variety Trial Publications, Extension specialists, seed dealers, and originating seed companies.	

Original composed by Drs. Pat Donald, Salliana Stetina, and Larry G. Heatherly, larryh91746@gmail.com; updated/revised by Larry G. Heatherly, Apr. 2025.