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ROOT LESION NEMATODE MANAGEMENT GUIDE

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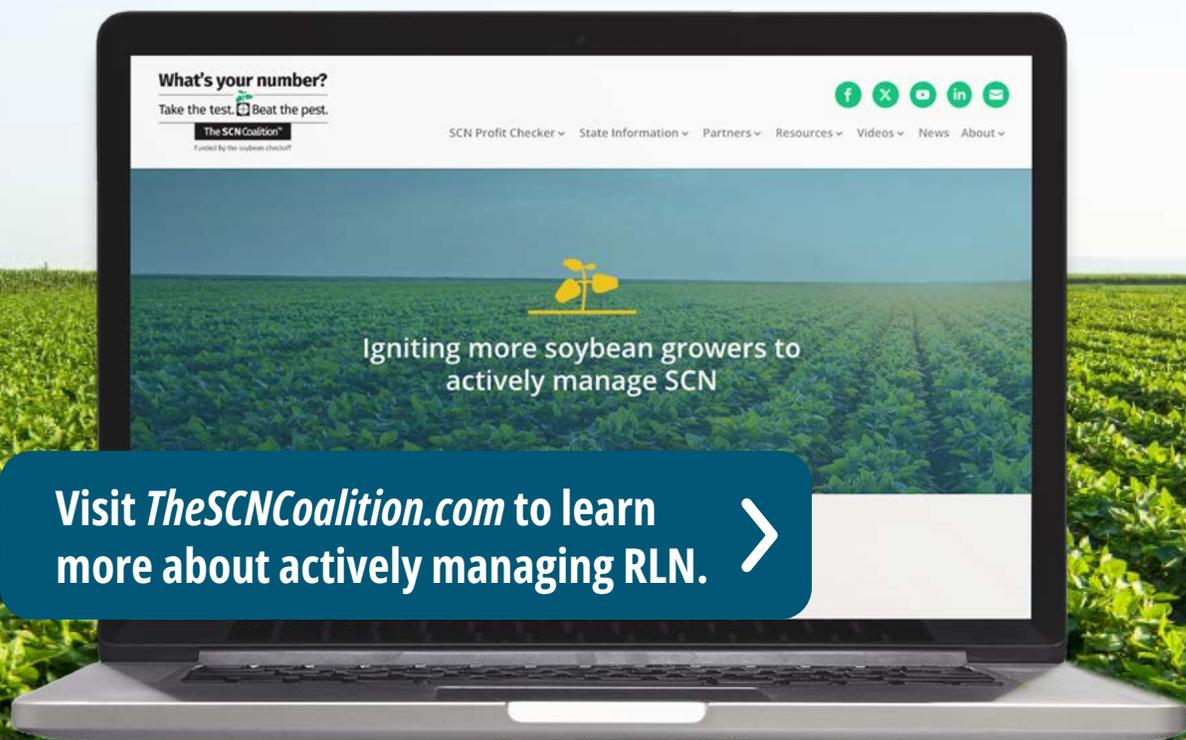


Proven Strategies Soybean Farmers Can Implement to Battle Root Lesion Nematode

Root lesion nematodes, RLN for short, are found in every soybean production area in the U.S. and Canada. RLN refers to a collection of species that kill root cells, causing damage that can translate to yield loss of soybean and many other crops, including corn.

The bad news? It's impossible to eradicate RLN from a field.

The good news? Whether you want quick tips or a scientific deep dive, this guide will help you determine whether you have RLN infestations, tailor a management strategy for your farm and achieve your yield goal.



Nematodes Are Everywhere. Including Your Field.

It's estimated that nearly 80% of all animals are nematodes. While most are beneficial and play essential roles in maintaining soil health, plant-parasitic nematodes can infect plant roots and rob yield. Soybean cyst nematode (SCN) remains the most important plant-parasitic nematode in soybean, but many other nematodes also feed on this crop and can reduce yield when their populations become high. Despite its wide distribution, we still know relatively little about the impact of one such threat – root lesion nematode (RLN).

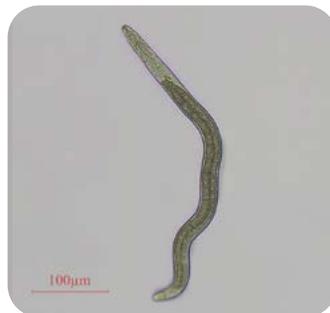


Photo credit: Guiping Yan, North Dakota State University

When is RLN a Problem?

With more than 100 species, RLN is widespread and, in many areas of the northern Midwest, even more common than SCN. Most RLN-infested fields have a low risk of yield loss, but the degree to which soybean plants are affected depends on several factors, with nematode species and population density being the most important.

- ✓ RLN species
- ✓ Population density
- ✓ Soil texture
- ✓ Abiotic environmental stresses

Due to its impact on grain and specialty crops, RLN is one of the most important groups of plant-parasitic nematodes in soybean production systems – along with SCN, root-knot nematode (RKN) and reniform nematode.

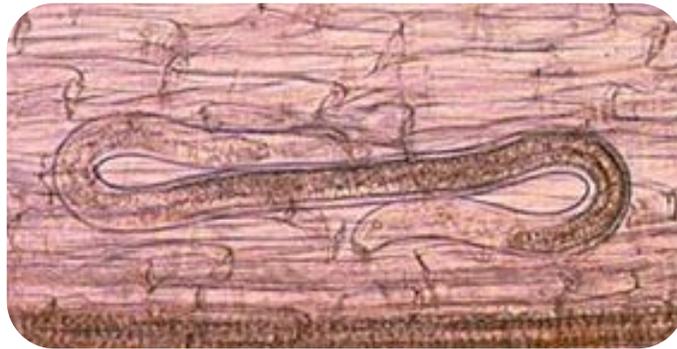
Some RLN species can cause significant yield loss in soybean – up to 10%. The impact extends beyond soybean. RLN can also reduce yield in rotational crops, including corn. When high RLN pressure is combined with its broad host range, the result can be significant and lead to recurring economic losses.

The good news is that RLN can be managed. By adopting a proactive, informed management plan, using the practices outlined in this guide, you can reduce nematode pressure and help protect soybean yield and overall crop productivity.

RLN 101: Biology and Reproduction

Root lesion nematodes (RLN) refer to a group of more than 100 microscopic nematode species in the genus *Pratylenchus*. These plant-parasitic nematodes are highly adaptable and feed on roots both externally and internally.

RLN is active throughout the growing season – from planting through harvest. Multiple generations can develop within a single season, and all life stages are capable of overwintering and feeding on soybean roots, even before plants emerge. In addition, RLN has a broad host range that includes many weed species and rotational crops, allowing populations to persist and increase across years.



RLN feeding inside a root (left) or outside a root (right), using a needle-like mouthpart (i.e., stylet) to empty the contents of a root cell. Photo credit (left): Dan Wixted



Stained roots show all life stages of RLN, including eggs. Photo credit: George Abawi, Cornell University

While RLN and SCN both attack soybean, there are some important differences in their biology and life cycle. Keep in mind that SCN refers to one nematode species while RLN refers to over 100 species. For example, RLN females do not enlarge and turn into cysts as with SCN. Instead, RLN remain worm-shaped or vermiform from the time they hatch as juveniles through adulthood, moving in and out of the roots to feed and lay eggs. Unlike SCN, which can grow on only a small number of host plants, RLN can feed on a wide range of plants, including corn and wheat. Finally, RLN's ability to overwinter at any life stage is a stark difference between the two.

RLN adults are ready to feed and reproduce the minute the seed is planted. When RLN kill roots, they can leave the dead roots and infect healthy roots or they can “shelter in place” in the roots, emerging when environmental conditions are favorable and infecting future crops. RLN's wide host range allows pest pressure to persist for decades. Your current soybean crop may not be threatened by low RLN population densities, but they can increase to problematic levels for future crops.

[Learn More About Nematode Behavior](#)

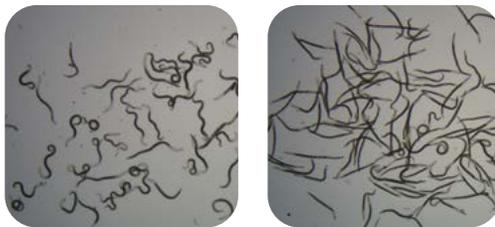
Understanding RLN Species

Because RLN refers to more than 100 species, not all of them affect soybean in the same way. Although 13 RLN species are known to feed and reproduce on soybean, yield studies have only been conducted on three: *Pratylenchus alleni*, *Pratylenchus brachyurus* and *Pratylenchus penetrans*.

Data-based models suggest that Wisconsin fields infested with *P. penetrans* experience yield losses of approximately 3% to 8%. Research is urgently needed, as the data are too limited to extend these estimates beyond Wisconsin or to evaluate the impact of other RLN species.



Pratylenchus penetrans juvenile feeding on a root hair of corn growing in a Petri dish.



Pratylenchus dakotaensis nematodes recovered from susceptible soybean plant roots in a controlled greenhouse experiment. Photo credit: Guiping Yan, North Dakota State University

It may be easy to assume that the remaining RLN species cause only mild damage to soybean, but research hasn't confirmed this, nor do we know the impact of multiple RLN species or their interaction with other nematodes and/or soilborne pathogens. Regardless, high RLN populations – no matter the species – warrant an active management plan due to their wide host range.

Table 1: RLN species with a known association to soybean in the U.S.

<i>Pratylenchus</i> (RLN) Species	Known U.S. Distribution ¹	Reported for Soybeans		
		Nematode Reproduction ²	Plant Damage ³	Yield Loss ⁴
<i>P. agilis</i>	Midwest, East	x		
<i>P. alleni</i>	Midwest, South	x	x	x
<i>P. brachyurus</i>	South, West	x	x	x
<i>P. coffeae</i>	South, West	x		
<i>P. crenatus</i>	East, Midwest	x		
<i>P. dakotaensis</i>	Midwest	x		
<i>P. hexincisus</i>	East, Midwest	x	x	
<i>P. neglectus</i>	East, Midwest, South, West	x		
<i>P. penetrans</i>	East, Midwest, South, West	x	x	x
<i>P. scribneri</i>	Midwest, South	x	x	
<i>P. sefaensis</i>	GA	x	x	
<i>P. vulnus</i>	Midwest, West	x		
<i>P. zaeae</i>	South	x		

¹ East: CT, ME, MA, NH, NJ, NY, PA, RI, VT.
Midwest: IA, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, WI.
South: AL, AR, DC, DE, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, WV.
West: AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY

² Numbers of RLN increased over time
³ Lesions on roots, and/or reduced growth of seedlings
⁴ Concluded from data collected in the field or research plots

Learn about the data used to construct Table 1

How to Spot RLN: Signs and Symptoms

RLN get their name from the dark lesions they create on plant roots as they feed. While lesion severity depends on RLN species, these lesions eventually expand, coalesce and kill the root – further limiting yield potential.

Visual symptoms of RLN damage are hard to spot below and above ground. Root discoloration from age or from damage caused by other pests and pathogens often obscures root lesions caused by RLN, making them undetectable to the naked eye.



Symptoms caused by RLN include dead patches on roots. Photo credits: Ann MacGuidwin, University of Wisconsin-Madison (left) and George Abawi, Cornell University (right)



The patchy distribution of RLN is evident in this pea field. Photo credit: Ann MacGuidwin, University of Wisconsin-Madison

Above ground, damage due to RLN may appear as patches of poor soybean growth. *P. penetrans* causes stunting during the early vegetative stages but usually the symptom disappears before flowering. In contrast, *P. brachyurus* creates patches of distressed plants that remain visible throughout the growing season. Because visual symptoms are unreliable, a yield monitor often offers the first clue that soybean plants are infected with RLN, followed by soil testing to confirm their presence.

RLN's Common Yield-Loss Partners

As it moves in and out of soybean roots, RLN creates openings for other yield-limiting soybean pathogens to enter and create further damage. Research on how RLN and pathogens interact on soybeans is limited, and much more is needed.



Explore a summary of state surveys and the prevalence of plant-parasitic nematodes in corn and soybean fields.

soybean or corn rotated with soybean in 14
ected in 12 of the 14 surveys. Spiral and Stunt
yield-damaging pests of soybean.
of the survey, and five most prevalent

You've Heard About RLN. What's Next?

As more roots are damaged by RLN and more plants become infected, water and nutrient uptake decline – leading to yield loss. Once detected in a field, you can consider RLN a permanent resident. And with its ability to produce multiple generations each growing season on most crops and weeds, population densities of RLN usually increase, meaning any level of RLN could build up to damaging levels over time. Even low initial levels of RLN can quietly build to damaging densities if not actively managed.

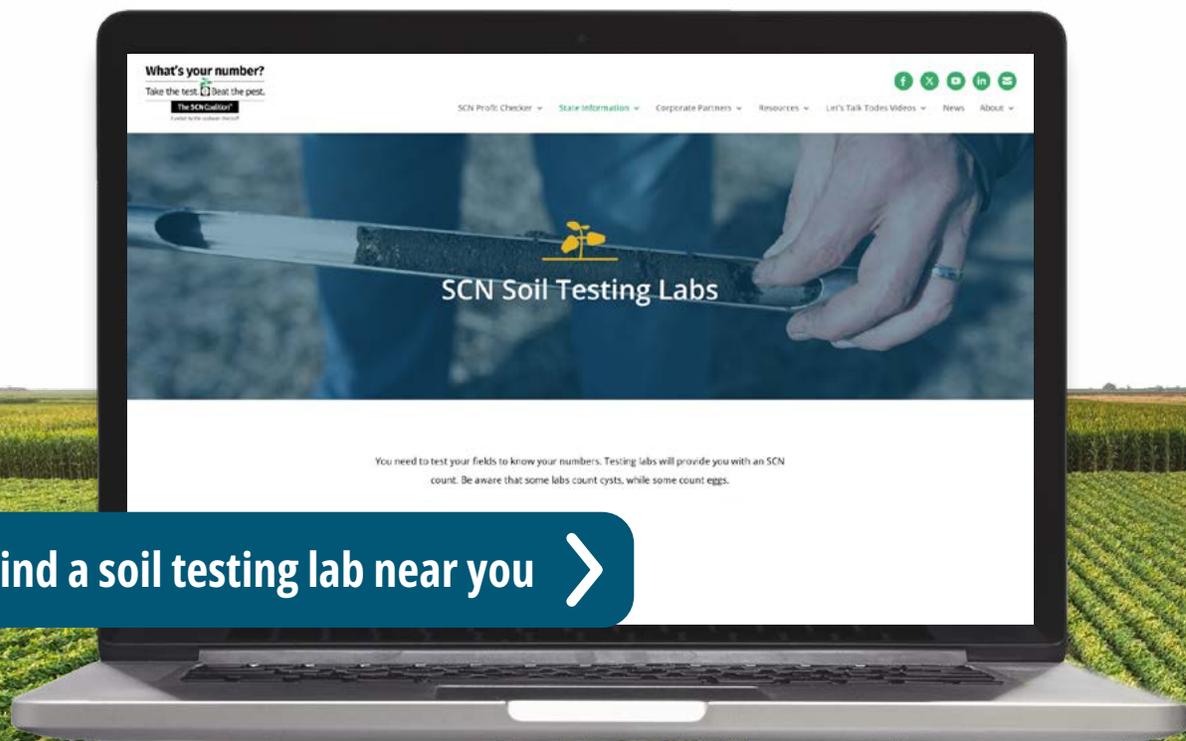
Once the crop is planted, there are limited or no in-season options to reduce soybean yield loss from RLN. However, a predictive soil test can reveal what long-term management strategies you should implement in subsequent seasons. The diagram below illustrates RLN's migratory endoparasitic feeding during all growth stages of soybean (early-, mid- and late-season) and in other crops in rotation, such as corn.

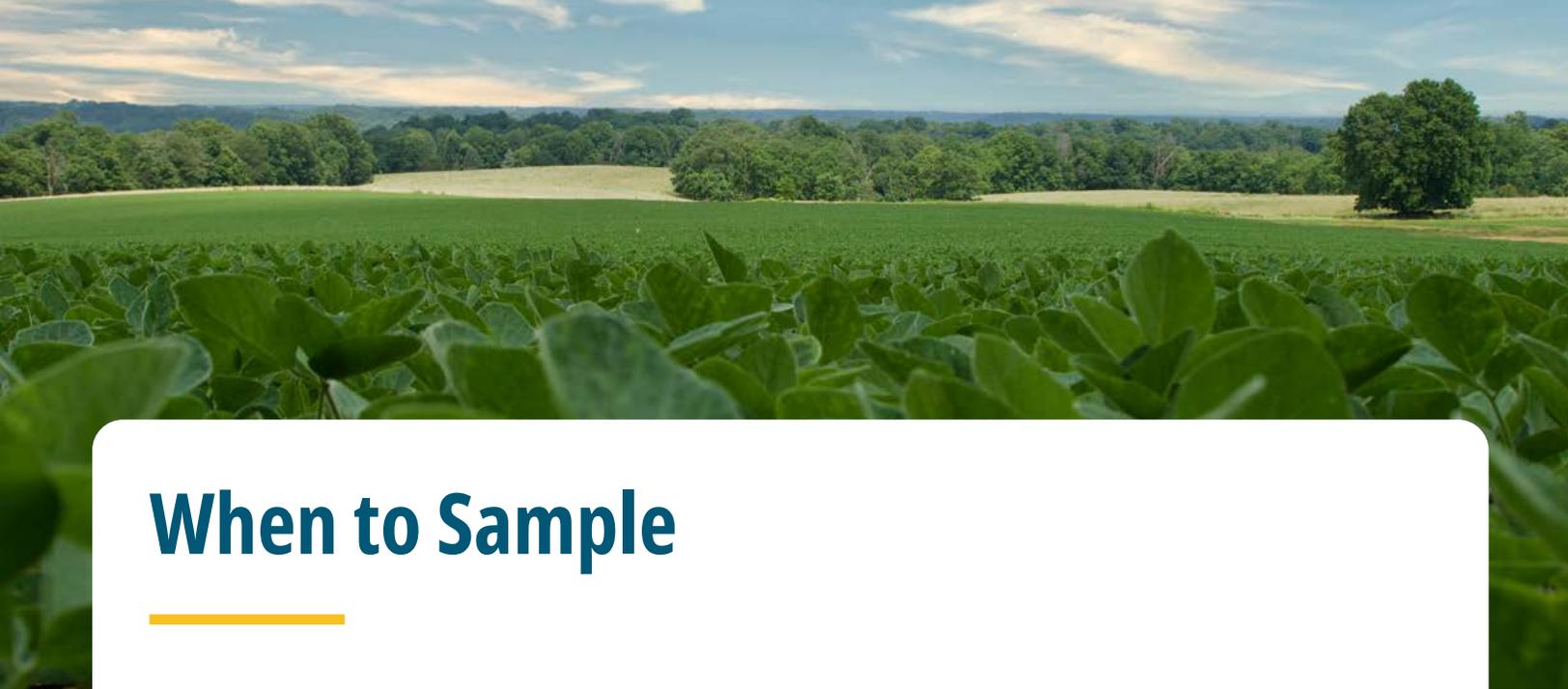


Start With a Soil Test

A soil test is the only way to confirm RLN pressure and is the foundation of an effective management plan. Timing, location and sample handling play a role in getting reliable results. Most samples collected for SCN can also be tested for RLN and other plant-parasitic nematodes. Because RLN moves between soil and root tissue, some laboratories provide counts from both soil and root samples. The most accurate estimate comes from submitting both plant roots and soil cores for analysis.

Besides manual collection of soil cores, other recently developed options include automated hydraulic soil samplers that can be mounted on small utility vehicles. These samplers can speed up the sampling process and sample more uniformly than soil cores taken by manually.





When to Sample

RLN population densities fluctuate throughout the season depending on crop stage, soil conditions and rotation history. The best time to sample depends on your objective:

- ✓ Sampling before or soon after planting provides a population density estimate that can be used to assess the potential for yield loss and helps guide early-season management decisions.
- ✓ Collecting samples around the R1 to R3 soybean growth stages captures RLN populations when they are actively increasing, making mid-season testing a valuable diagnostic tool, especially when both soil and root samples are collected.
- ✓ Post-harvest sampling gives the most accurate estimate of the numbers that will carry over into future seasons.

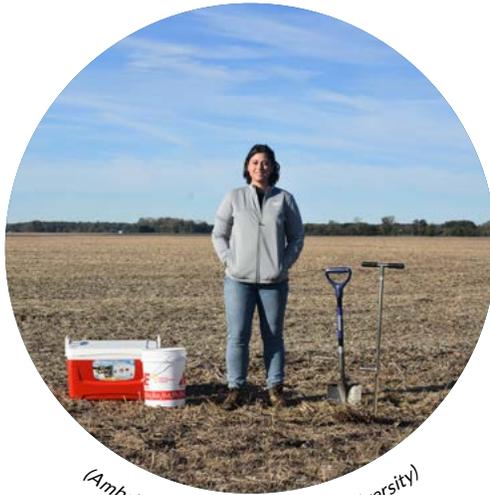


Where to Sample

RLN distribution within a field is uneven, and relying solely on visible symptoms can lead to under sampling and misdiagnosis.

Use yield maps or field history to identify low-yielding areas that may be associated with damaging nematode pressure. Collecting samples from both symptomatic and neighboring asymptomatic areas provides the best comparison. Avoid sampling soil and roots from and around dead plants, as RLN requires living roots to develop. A zigzag or “W” sampling pattern across the target area helps ensure representative coverage.

For a more detailed assessment, divide the field into natural areas or management zones, such as wet versus dry areas, distinct soil textures or depths or regions with different cropping histories – and sample each separately.



(Ambria Small, The Ohio State University)

What you need for RLN soil sampling:

Since RLN moves between soil and roots, both should be sampled. Materials for RLN sampling include:

- 1-inch-diameter cylindrical soil probe (or shovel)
- Bucket
- Cooler
- Plastic bags
- Permanent marker

Use a probe or trowel at a slight angle to collect soil samples from the root zone at the base of the plant, typically 6 to 12 inches deep.



1

If a cylindrical probe is not available, use a shovel. First, clear the surface of the soil.

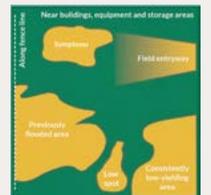
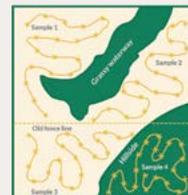
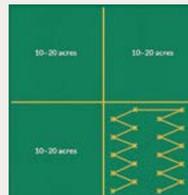


Discard the sides of the soil on the shovel and keep the central part of the subsample.



2

Collect 10 to 20 soil cores that are 1-inch-diameter in a zigzag or “W” pattern across the entire area to be sampled.



Get a closer look >

3

Combine multiple subsamples of soil from an area into a clean bucket, mix the soil gently but well, and place approximately 1 pint (500 g) of soil into a plastic or freezer-grade bag. Be sure to label the bag clearly with field and sample information or GPS coordinates if available.



4

For root sampling, carefully dig up 2 to 5 soybean plants from the same area where soil was collected. Shake off excess soil but don't wash the roots.



5

Take the unwashed fibrous root system and place it in a separate bag or in the soil sample bag to prevent drying.

Keep samples cool and out of direct sunlight immediately after collection. Do not add water. If samples cannot be shipped the same day, store them in a refrigerator – never a freezer – to avoid killing the nematodes. Send samples to a diagnostic lab as soon as possible.



Interpreting YOUR RESULTS

Since damage thresholds based on population densities vary by region, soil texture and lab extraction methods, it is important to work with your local diagnostic lab or Extension specialist when interpreting results. RLN are common in many fields, but their presence alone does not always indicate yield loss.

Identifying RLN to genus is straightforward, but distinguishing species is more difficult. Results are typically reported as actual nematode numbers, but interpretation often relies on categories such as low, moderate, or high to guide management decisions.

Low counts suggest that yield loss is unlikely in the current season and may remain unlikely if rotations and cover crops are selected carefully. Moderate counts warrant incorporating RLN management into rotation decisions. High counts indicate a greater risk of yield loss and may justify a nematode-protectant seed treatment. At higher levels, species identification becomes more important for refining management.

[*Click here to view more examples of nematode test reports*](#)

Identification based on DNA can confirm the identity of the RLN species present in a sample, but this is not a common service offered by soil testing labs. If the soil testing lab you use doesn't identify species, ask whether male nematodes were observed as this can help narrow down which species might be present.

[*Click here to learn how the numbers presented in test results are determined.*](#)

While damage varies by species and populations, management is a long-term process, so always consider RLN when planning for a high-yielding soybean crop. Keep a record and retest fields every few years to monitor trends and evaluate success and work with your local expert to develop a plan that fits your field history, crop rotation and yield goals.



Clusters of nematodes in a Petri dish culture

Why RLN soil test results are variable

It all depends on where you put the probe. A 1/2-inch difference can mean the difference between zero and 150 RLN.



Why are RLN Numbers Variable?

Once detected, RLN should be viewed as a long-term plant health concern because it can reproduce on a wide range of crops and weeds. Keeping a record of soil test results over time is a valuable way to track whether management efforts are reducing risk or if populations are increasing. Understanding why RLN numbers fluctuate from one sample to the next helps growers make meaningful comparisons across years and identify true trends rather than short-term variations.

Field Conditions

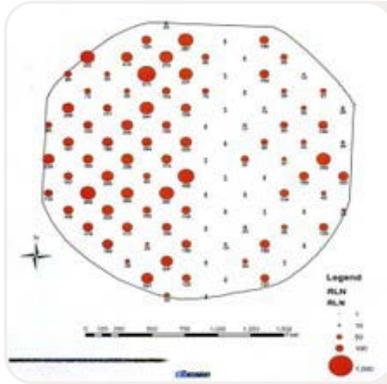


From the nematode's perspective, field conditions can shift substantially from year to year. Factors such as the crop planted, plant population density, row spacing and the presence or absence of weeds all influence how quickly RLN populations increase.

What soybean growers observe aboveground often looks very different from RLN's "worm's-eye view." Below the soil surface, conditions change dramatically when the field rotates to a different crop or becomes infested with weeds. Root biomass, root architecture, rooting depth and the organic matter left behind by previous crops are far more important drivers of RLN population dynamics than soybean canopy traits.

Sampling Pattern

RLN has a patchy distribution across a field, often reflecting variations in soil texture, organic matter and soil chemistry. These factors impact soil moisture, which greatly affects how well RLN can move through the soil and infect roots. Soil moisture also affects plant growth, which in turn influences nematode reproduction. Because of this patchiness, samples that happen to include nematode “hot spots” may show much higher counts than samples collected outside those areas.



The size of each dot is proportional to the number of P. penetrans recovered from 105 samples collected from an irrigated soybean field soon after planting. Pesticide history accounts for the largest difference between the two halves, with soil factors accounting for the rest of the variation.

Time of Year Samples Were Collected

Nematode numbers are naturally the lowest in seasons that are very cold or very hot. Counts can change dramatically between early season and harvest (Table 2), and reproduction of RLN can be highly variable within a single field due to differences in the soil environment. RLN numbers decline when soil freezes and plants die. The rate of decline can vary widely across a field due to variation in the soil environment.

Table 2. *Season-long population density increase of the RLN species (Pratylenchus penetrans) on SCN-resistant soybean grown in irrigated loamy sand soil.*

	Multiple spots in the field*	Single location in the field**
Field	Average x-fold increase	Range of x-fold increase
1	8	0 - 44
2	0	0 - 1.1
3	9	0 - 24
4	30	0 - 85
5	11	0 - 25
6	5	0 - 16
7	31	0 - 159

*Between 8 and 25 plots were sampled and the counts averaged.

**Lowest and highest rate of increase among many plots in the same field.

Lab That Ran the Samples

Different laboratories processing the same soil sample are unlikely to report identical nematode counts. Multiple methods exist for extracting RLN from soil, each with its own strengths and limitations, and none recover every nematode present. Labs typically balance the “miss” rate (i.e., recovery efficiency) with the “ease of use” (i.e., practicality) of a method when selecting the procedure they use. As a result, counts can vary among labs. For growers, the most important factor is often how the lab interprets the numbers and classifies them into meaningful categories – such as low, moderate or high – based on its experience and regional benchmarks.

Another difference among laboratories is whether they process soil, roots or both when extracting nematodes. Some labs recover RLN from root fragments present in the soil sample, while others extract nematodes from intact root tissue collected with the plants. These differences in what is processed can also influence the final nematode counts reported.



Soil sample with dead soybean root fragments collected from a Wisconsin field during winter. In this sample, the nematode counts from root fragments matched those from the soil. Some labs include counts from root fragments in the sample and some don't.

Implement RLN Management Solutions

While it's impossible to eliminate its presence in fields, proper active management over time can help you reduce the impact of RLN. The main goals of active management are to:

- ✓ Improve soybean health and yield
- ✓ Improve the health and yield of rotation crops
- ✓ Keep RLN numbers low

No single management practice can achieve all three goals. An integrated approach that combines several strategies is the most effective way to reduce the impact of RLN on your crop. Fields should also be retested every few years to monitor population trends and evaluate whether management efforts are working.

Management options include crop rotation, use of nematode-protectant seed treatments and other cultural practices that promote root health. Work with your local expert to develop a plan that fits your field history, crop rotation, preferences and yield goals.

First, Establish Priorities

RLN management should be integrated with broader nematode control strategies. If SCN is present in the field, it should take priority when making rotation decisions and developing nematode management plans.

Reniform nematode and RKN are also major concerns in southern soybean-producing regions of the United States. When their population densities are high, resistant soybean varieties should be used whenever available. Other plant-parasitic nematodes – including lance, sting, dagger, stubby-root, spiral and pin nematodes – may be found in agricultural fields but are less likely to reach damaging levels. If these nematodes appear in unusually high numbers, consult your local expert for management guidance.



Seeing cysts or galls in your fields may indicate other nematode species like SCN and RKN are present.

Resistant Soybean Varieties

Unlike SCN, currently there are no soybean varieties with resistance to RLN. Reproduction of RLN varies among soybean varieties, so be mindful that resistance to one nematode species does not imply resistance to all nematode species. If other nematodes, such as SCN, RKN or reniform, are present in your fields at damaging levels, design your management program to target these. For example, SCN-resistant varieties don't reduce RLN reproduction, so SCN, not RLN, should guide your variety selections. Further research is urgently needed to develop soybean varieties with resistance to RLN. Thankfully, even without resistant soybean varieties, other management options and strategies can help reduce risk and protect yield.



Crop Rotation

While no single crop will eliminate RLN from a field, crop rotation offers important soil health benefits whether nematodes are present or not — and it may already be part of your farm plan.

Unlike SCN, which primarily infects soybean, RLN has a broad host range and can damage nearly every crop in your rotation. Management decisions made in corn, wheat or even cover crops, can influence RLN pressure in future soybean crops. The good news is that some crops support less RLN reproduction than others. Any reduction in RLN population densities during non-soybean years can benefit your next soybean crop, so choose rotation crops wisely.

Recommended rotation crops depend on the RLN species present. Small grains support less reproduction of *P. penetrans* than soybean and corn, while winter wheat and certain vegetables support less reproduction of *P. brachyurus*. Because RLN includes more than 100 species, changing crops may also shift the composition of species present in your field.



Cover Crops



Cover crops can either suppress or support RLN populations, depending on the species. Many leguminous cover crops support reproduction of RLN. Mustard and canola are also good hosts but may reduce population densities when incorporated as a green manure.

Pearl millet (*Pennisetum glaucum*) helps reduce *P. penetrans* population densities while *P. brachyurus* population densities decline when sunn hemp (*Crotalaria juncea*) and showy rattlepod (*Crotalaria spectabilis*) are grown. Other rotation crops offer species-specific resistance. For example, certain wheat varieties are resistant to *P. neglectus* and certain alfalfa varieties are resistant to *P. penetrans*.

Weed Management



Weed management is important for management of RLN, as multiple common annual and perennial weeds can host RLN and allow populations to persist even when cash crops are not present. Keeping fields weed free between crops and during fallow periods helps prevent population density buildup.

Nematode-Protectant Seed Treatments

Nematode-protectant seed treatments can be useful in fields with high RLN pressure, especially when population densities of *P. penetrans* or *P. brachyurus* are high. Because all life stages can overwinter and begin feeding on soybean roots before emergence, these seed treatments help protect roots during this vulnerable early period.

Keep in mind that not all products labeled for SCN provide activity against RLN, especially biologicals. Choose seed treatments specifically labeled for RLN, and consult your local expert for recommendations suited to your region and field conditions.



Other Cultural Practices



While strong root systems support higher yield, they can also provide favorable conditions for RLN reproduction. Cultural practices that improve soil structure, such as tillage in compacted soils, can help roots develop more vigorously. Adequate soil fertility also is important, as well-nourished, healthy plants are generally better able to tolerate RLN damage.



For additional soil testing recommendations, state-specific resources or to learn more about actively managing RLN and other damaging nematodes, visit:

[TheSCNCoalition.com](https://www.thescncoalition.com)

Connect with us on social @[thescncoalition](https://www.thescncoalition.com)



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