2024 Final Report: Delaware Soybean Board

In-Season Reproduction of Root-Knot Nematodes

Dr. Alyssa Betts, Associate Professor and Extension Specialist, Plant Pathology
Department of Plant and Soil Sciences, University of Delaware, Georgetown, DE
akoehler@udel.edu | (302)242-9056 | @UDPlantPath

Project Overview:

Soybean production in the United States can be limited by many factors– one of the most widespread is root-knot nematodes (RKN, *Meloidogyne* spp.). Several species have been identified, with the most abundant and damaging species in DE being Southern RKN (*Meloidogyne incognita*) (Faske, et al. 2021). RKN thrive in sandy soils and claim thousands of dollars' worth of damage every year. Aboveground symptoms of RKN infection may be mistaken for nutrient deficiencies or poor plant development, including stunting, wilting, and discoloration of plant tissue. While most susceptible hosts show these symptoms, other hosts used as rotation partners may not show decline in plant development but can still act as a host allowing for reproduction of RKN. Selecting a resistant or non-host rotation partner can help with management of RKN populations, however the wide host range of these nematodes makes it difficult to select a viable rotation partner. The proposed project aimed to screen reproduction on known RKN host crops to assess root symptoms and population increases compared to soybean. Project objectives included: 1) Track in-season nematode populations following the use of multiple host plants. 2) Share research findings through extension events and use findings to inform future management trials.

Project Activities and Methods:

Objective 1. Track in-season nematode populations following the use of multiple host plants.

At the University of Delaware Carvel Research and Education Center, a field has been used for root-knot nematode research for over a decade. Within this field four host crops: soybean, corn, susceptible lima bean, lima bean with RKN resistance were planted and observed for RKN reproduction. In addition to natural inoculum, plots were inoculated at the time of planting by adding 125 g of symptomatic root pieces from RKN infested tomato plants per plot. Nematode samples were collected from plots at the time of planting (June 10, 2024) and at the end of the growing season (September 16, 2024). Each plot consisted of four rows with the middle two rows receiving inoculum (Figure 1). The two inoculated rows were split into 10-foot rows totaling four replications for each host crop. At maturity for each host, plants were dug, and root systems were rinsed to remove excess soil. Roots were rated for level of nematode galling and then processed to extract nematode eggs. Eggs were counted under a microscope and converted to egg count per gram of root to measure the reproductive potential of each host.

Figure 1: RKN Mini Plot Host Trial set in Georgetown, DE. From left- four rows of resistant lima beans, susceptible lima beans, corn, and susceptible soybean.

Objective 2. Share research findings through extension events and use findings to inform future management trials.

Findings from this project were shared through the University of Delaware's Weekly Crop Update, which reaches over 700 growers, consultants, and stakeholders and provides a platform to discuss disease concerns and other production issues. Data on RKN host reproduction was also shared through training events and extension presentations such as the 2025 Delaware Ag week and in other winter 2025 meetings.

Results and Discussion:

The host reproduction trial was completed in Georgetown, DE from June to October 2024. The field was maintained as dryland and 2024 saw a large drought which added to plant stress. Nematode soil samples were first collected at time of planting and inoculation on June 6, 2024. Minimal RKN populations were recovered at the start of the trial. This field has a history of only RKN, and no soybean cyst nematodes (SCN) were recovered. End of season soil samples were collected from all plots on September 16, 2024. Populations of RKN ranged from 0-260 RKN per 500cc of soil surrounding resistant lima beans, 1,440-16,800 RKN per 500cc of soil surrounding susceptible lima beans, 0-30 RKN per 500cc of soil surrounding corn plants, and 0-180 RKN per 500cc of soil surrounding soybeans. In addition to soil samples, roots of individual plants were excavated to rate galling and extract RKN eggs. Both varieties of lima beans were harvested on September 4, 2024 and corn was terminated on September 16, 2024. Soybeans had not yet reached maturity and would have been harvested late October. Due to the mixed harvest dates within the trial, soybeans were mistakenly mowed over in preparation for planting small grains for 2025 trials examining RKN in soybean at various small grain/planting date interactions. The soybean plots were unable to be recovered for proper processing of the root systems. Lima bean and corn roots were assessed using the Bridge and Page gall rating scale. Extensive galling was observed in the susceptible lima bean plants (Figure 2). RKN eggs were then extracted and quantified (Table 1). One of the most important aspects of this project has been trying to understand the level of RKN reproduction

occurring in corn. While corn can be a beneficial rotation partner for soybean fields with SCN, we are finding that the level of RKN reproduction occurring in corn has been underestimated due to the lack of notable symptoms in corn shoot and root growth. As shown in Table 1, root gall ratings remained at 0, however reproduction still occurred in the corn. The lima beans in this trial served as extreme ends of a continuum with the susceptible lima bean at very high galling and reproductive levels while the resistant variety showed reduced galling and reproduction in comparison. In lima beans, galling and reproduction are controlled by different genetics and the line used in this trial was selected for both low galling and reduced reproduction. Corn reproduction levels were lower than the susceptible lima bean, but still high enough to lead to problems in soybean rotations. Populations of RKN in soil samples from the corn and soybean plots were lower than expected. This may be due to the extreme drought conditions that kept root systems stressed and much smaller than a high performing environment. Corn heights were severely stunted which impacted overall plant biomass. The lima beans may have handled the drought conditions better with adequate root biomass that allowed for extensive RKN populations to develop on the susceptible line. In on-farm observations over 2023 and 2024, we have been tracking RKN populations and observing elevated populations in soil samples from fields following a corn rotation. As seen by the lima bean data, host resistance is the most effective way to improve in-season pressure while also working to lower overall RKN levels within a field. In soybean, RKN resistance has often only been available in maturity groups 5 and above, but a few promising varieties within maturity group 4 are coming to market. We aim to repeat this trial a second year adding in a resistant soybean as well as sorghum to continue to understand RKN reproduction across multiple crops and develop multi-year approaches to host rotation that maximize soybean yield potential while improving overall field productivity through reduced RKN populations.

Figure 2: Lima bean root systems with extensive galling from RKN show disease pressure was high in the test plots.

Table 1: RKN Soil Sample Recovery, Galling, and Egg Counts Across Host Crops in Georgetown, DE

Host	**RKN End of Season Soil Sample** [z]	**Avg. Gall Rating** [y]	**Avg. Egg Count per Gram Roots** [x]
Resistant Lima Bean	26.9 b [w]	0.24 b	157 b
Susceptible Lima Bean	6,483.4 a	4.76 a	784 a
Corn	8.2 b	0.00 b	243 b
Soybean	19.1 b	n/a[v]	n/a

[z] Number of nematodes per 500 cc soil sample.

[y] Lima bean and corn roots were assessed using the Bridge and Page gall rating scale.

[x] Eggs were extracted from roots and counted under a microscope. Numbers represent avg. egg count per gram of root.

[w] Means followed by the same letter are not significantly different based on Tukey's HSD (P=0.05).

[v] Soybean plots were prematurely terminated when fall planting equipment entered the field.

References:

Bajek V., Gauthier N., Leonberger K., Rudolph R. 2021. Root-knot Nematode in Vegetable Cropping Systems. *University of Kentucky Extension Plant Pathology: Plant Pathology Fact Sheet.*

Faske TR., Mueller J., Thiessen L. 2021. An Overview of Root-Knot Nematodes. *Crop Protection Network.*

Shrestha J., Subedi S., Thapa B. 2020. Root-knot nematode (*Meloidogyne incognita*) and its management: a review. *Nepal Journal of Agriculture and Natural Resources.*

Funded Budget:

Graduate Student Stipend (17% effort) ($32,667/yr)	=$5,554
Fringe benefits 10%	=$555
Nematode soil samples (182 samples, $20 per sample)	=$3,640
Total Budget	=$9,749

Research Dissemination and DSB Recognition:

January 16, 2025 - DE Ag Week
February 10, 2025 - Nematode Seminar
February 26, 2025 - Southern Soybean Disease Workers

Public Summary:

In recent years, Root-Knot Nematode (RKN, *Meloidogyne incognita*) has been a leading yield reducer of soybeans across the region. Unfortunately, RKN has a tremendous host range, including many vegetable crops, and rotation does not guarantee reduction of nematode populations for soybean production. Symptoms of RKN are not as prominent in corn, but preliminary soil samples in 2023 indicated that RKN reproduction on corn could be higher than anticipated. By tracking reproduction rates on multiple hosts, this project seeks to improve understanding of nematode reproduction rates and crop rotation recommendations for soybean production. This project funded two months of support for a graduate student focusing on management of root-knot nematodes to conduct host reproduction trials. Project objectives included: 1) Track in-season nematode populations following the use of multiple host plants. 2) Share research findings through extension events and use findings to inform future management trials. Soil sampling, root ratings, and RKN enumeration across a susceptible lima bean, resistant lima bean, corn, and soybean quantified differences in RKN reproduction that can have implications to field performance and soybean yield. While corn can be a beneficial rotation partner for soybean fields with SCN, the level of RKN reproduction occurring in corn has been underestimated due to the lack of notable symptoms in corn shoot and root growth. Host resistance is a powerful tool to reduce in-season symptoms and reduce overall RKN populations within the soil. While RKN resistance in soybean has been limited in maturity groups appropriate for the region, new options are entering the market. This trial will continue for a 2nd year expanding to include a soybean variety with RKN resistance and sorghum. Findings from this project will help soybean farmers make informed decisions regarding RKN management.

Please contact Alyssa Betts (akoehler@udel.edu) with any additional questions.