2021 Final Report: Atlantic Soybean Council
Survey and Seed Treatment Efficacy Trials to Improve Management of Nematodes across DE and MD

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Project Overview:

Soybean cyst nematode (SCN) (*Heterodera glycines*) consistently ranks as the most destructive pathogen of soybeans (*Glycine max* (L.) Merrill) across the United States (Allen et al. 2017) and is the most significant nematode affecting soybeans in Delaware and the eastern shore of Maryland. Females establish permanent feeding sites on roots and turn into cysts that each contain hundreds of eggs. There may be several generations within a single growing season and recalcitrant cysts and eggs can persist in the soil for long periods. SCN has been present in Delaware since 1979 and Maryland since 1980. Nematodes often go undiagnosed and can be very damaging to soybean production, reducing both yield and quality. Growers have relied heavily on resistant varieties, primarily using the PI88788 resistance source. Long-term exposure to this resistance gene has selected for SCN populations that are able to overcome this source of resistance. Detailed SCN surveys were conducted across Delaware in 1993 and 2009 (Mulrooney and Gregory, 2010). From these surveys, it was observed that populations shifted from predominately race 3 to race 1. During the 2009 survey, elevated reproduction on PI88788 was observed at rates of 44-80%. Over the past decade, it is likely that resistance has continued to break down, but there has been limited survey work in the region and most growers are unaware of field SCN population levels or the importance of scouting/sampling. Surveys were initiated in DE and eastern shore MD in 2019 and over 50% of the 60 farms surveyed had SCN present. In addition to SCN, lesion, root knot, dagger, and other genera of nematodes may be affecting soybean yield potential. When host resistance is unavailable or not providing adequate protection, other management strategies are needed to reduce yield loss from nematode feeding. In recent years, ILeVO, with active ingredient fluopyram, has been one of the primary seed treatment products marketed for management of SCN and soybean sudden death syndrome (SDS). Most work examining efficacy of ILeVo has been conducted in the Midwest and there is limited SCN efficacy data for ILeVO performance in the Mid-Atlantic. In September 2019, Syngenta announced that the EPA granted registration for a new seed treatment, Saltro, with

active ingredient pydiflumetofen. New on the market in 2020, Saltro is labeled to protect plants from SDS and nematodes. As a new product, there was no local data available for the performance of Saltro to manage SCN in the Mid-Atlantic. Project objectives included: 1) Determine which nematode species are present in soybean acreage across Mid-Atlantic farms. 2) Screen seed treatment products for efficacy to reduce soybean yield loss from soybean cyst nematode. 3) Share research findings through extension publications, web outputs, and extension events. Foster regional dialogue concerning nematode sampling observations across DE, MD, PA, and NJ. This project funded thirty percent of annual effort for a M.S. student focusing on diseases of soybeans along with travel support to visit field sites and support to submit soil samples to provide insight on the nematode species present in the region and among plots following seed treatments. As we continue to deal with breakdown of resistance gene efficacy and subsequent increases in SCN populations, the goal of this proposal was to increase knowledge of regional nematode populations and species distributions while also generating local efficacy data on currently available seed treatment products.

Project Activities and Methods:

In 2019, a survey project was conducted across DE and MD and 57% of fields had SCN present. From this project, a field site with high SCN pressure was identified at the Carvel Research and Education Center in Georgetown, DE to conduct nematode seed treatment trials. In recent years, ILEVO, with active ingredient fluopyram, has been one of the primary seed treatment products marketed for management of SCN and soybean sudden death syndrome (SDS). Most work examining efficacy of ILEVO has been conducted in the Midwest and there is limited SCN efficacy data for ILEVO performance in the Mid-Atlantic. In Iowa, ILEVO significantly reduced *H. glycines* hatching, motility, root penetration, and reproduction (Beeman and Tylka 2018). A more widespread study in the Midwest showed a 2.8% yield increase when ILEVO was included as part of the soybean seed treatment mix, even without SDS pressure, which was partially explained by the unexamined effects on SCN (Gaspar et al. 2017). In September 2019, Syngenta announced that the EPA granted registration for a new seed treatment Saltro, with active ingredient pydiflumetofen. This product is labeled to protect plants from SDS and nematodes and became available in 2020. As a new product, there was no local data available for the performance of Saltro to manage SCN in the Mid-Atlantic.

<u>Objective 1.</u> Determine which nematode species are present in soybean acreage across Mid-Atlantic farms.

Across DE and MD, 100 farms were targeted for soil sample collection. At each field site, one farm-representative nematode sample was submitted by collecting soil moving in a zig zag pattern across the field. In areas with a known history of SCN populations samples comparing health versus worse looking areas were collected. In total, 135 samples were collected as part of the project. Soil samples were submitted to the NCDA Nematode assay services and processed for presence and population counts of SCN, root knot nematode, lesion, lance, ring, spiral, and stubby root nematodes.

Objective 2. Screen seed treatment products for efficacy to reduce soybean yield loss from soybean cyst nematode.

Two seed treatment products, ILeVo and Saltro, along with a non-treated control of plain seed were set up in a randomized complete block design with five replications at two test locations. Plots were 25 ft in length and 10 ft wide. Within each of the 15 treatment plots at each test location, a plot-representative soil sample was collected by combining 30-40 soil cores per plot at three time points throughout the growing season (Figure 1). Soil samples were collected at the time of planting, approximately 30 days after planting, and at harvest. Samples were submitted to the North Carolina Department of Agriculture Nematode assay service. Population counts were provided for SCN, root knot nematode, lesion, lance, ring, spiral, and stubby root nematodes. After the seed was planted, soybean seedlings were monitored for phytotoxicity. Plots were scouting for other soybean diseases, including soybean sudden death syndrome (SDS), throughout the duration of the trial. At 30 days after planting, 5 plants per plot were dug and destructively sampled to assess the number of SCN females present on the roots (Figure 2). Plant roots were brought back to the lab and rinsed over sieves to catch SCN females that were enumerated under the microscope (Figure 3). Plots were harvested at the end of the season using a small plot combine.

Figure 1: Equipment for collecting soil samples

Figure 2: M.S. student Lexi Kessler observing plants 30 days after emergence.

Figure 3: M.S. student Lexi Kessler at the microscope (left); Cream to pale yellow colored SCN females under microscope magnification following root blasting (right).

Objective 3. Share research findings through extension publications, web outputs, and extension events. Foster regional dialogue concerning nematode sampling observations across DE, MD, PA, and NJ.

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. In August 2021, a Nematode Field Day was organized and held at the Carvel Research and Education Center in Georgetown, DE. Participants were able to view the field site and walk trial plots. A Delmarva Farmer article highlighted main discussion points of the field day. In addition to communicating with the public, this project also sought to foster regional discussion by hosting a webinar at the end of the project. The webinar was held in Nov 2021 and project results were shared with agricultural professionals from DE, MD, PA, NJ, NY, and VA. Nematode trials were discussed at the 2022 Delaware Ag Week Agronomy Soybean Session.

Results and Discussion:

In total, 135 samples were collected as part of the project. The three nematode genera of concern most frequently recovered included soybean cyst, root knot, and lesion (Table 1). As in previous surveys, SCN had the highest percent of samples above EDT. Of note, lesion nematode continues to be isolated at high frequency.

Table 1: Nematode Survey Results

Nematode Species	**Total Samples**	**Percent of Samples with Recovery[z]**	**Soybean Economic Damage Threshold of High[y]**	**Number of Samples above the EDT**	**Percent of Samples with Populations above High EDT[x]**
Soybean Cyst[w] (*Heterodera*)	56	41.5	> 60 per 500 cc soil	34	60.7
Root Knot (*Meloidogyne*)	10	7.4	>170 per 500 cc soil	2	20.0
Lesion (*Pratylenchus*)	105	77.8	>300 per 500 cc soil	11	10.5

[z] Percentage out of 135 soil samples
[y] Soybean economic damage thresholds as established by Virginia Tech Cooperative Extension https://hortintl.cals.ncsu.edu/sites/default/files/documents/spes-15.pdf
[x] Percentage out of samples testing positive for indicated genera
[w] Soybean cyst nematode counts represent cysts and second-stage juveniles

Field Trials

In the SCN trial field in Georgetown, DE, a composite soil sample was collected for HG soil type analysis. This field was identified as HG type 2, Race 5 and the nematode population was

able to reproduce at a 66% rate on the PI88788 resistance source (Table 2). The field site in Wye Mills, MD had lower SCN pressure.

Table 2: Results from sending a nematode sample for race and HG typing.

Indicator Line= Source of Resistance	Rep 1	Rep 2	Rep 3	Rep 4	Female index (FI)=	≥10%
1) PI 548402 (Peking)	12	11	18	19	7.7%	-
2) PI 88788	116	151	134	112	66.2%	+
3) PI 90763	3	4	2	1	1.3%	-
4) PI 437654	0	0	0	0	0%	-
Pickett	40	35	41	60	22.7%	+

HG type: 2
Race: 5

Comments: This SCN population is able to reproduce at a low level (<10%) on PI 548402 (Peking) and PI 90763, and at a high level (>60%) on PI 88788 and Pickett. The population was unable to reproduce on PI 437654.

Georgetown, DE

Treated seed emerged faster and at a higher rate than non-treated plain seed (Table 3). Canopeo, an app used to assess differences in green canopy cover, was used at the end of the season and the plots with plain seed had the lowest numerical rating of greenness along with visibly fewer leaves remaining. Significant differences in yield were not observed, but the lowest numerical yield was observed in plain seed.

Soybean cyst nematode recovery was lowest at the time of planting. Baseline SCN populations ranged from 10-140 juvenile nematodes per 500 cc soil with no difference in averages across each of the treatments and non-treated control. Within 30 days after emergence, populations remained similar in all three treatments, including the control. Prior to harvest, no significant SCN population differences were present among treatments, but populations in all treatments were at the highest levels of the season (Figure 4). In addition to soil samples, five plants per plot were dug up 30 days after emergence (DAE) to sample for SCN cysts via a root blasting protocol. Numbers of cysts recovered from Saltro and ILEVO treated plants were numerically lower than the non-treated seed, but no statistical differences were observed.

Table 3: Emergence and Yield Data from 2021 SCN seed treatment trial in Georgetown, DE

Treatment	% Emergence	% Emergence	Canopeo	Yield (bu/a)
Plain Seed	53.3c	56.8c	31.24	42.2
Saltro	82.4a	85.5a	47.90	48.7
ILEVO	68.9b	79.5b	34.96	48.8
p-value	<0.001	<0.001	0.005	0.18

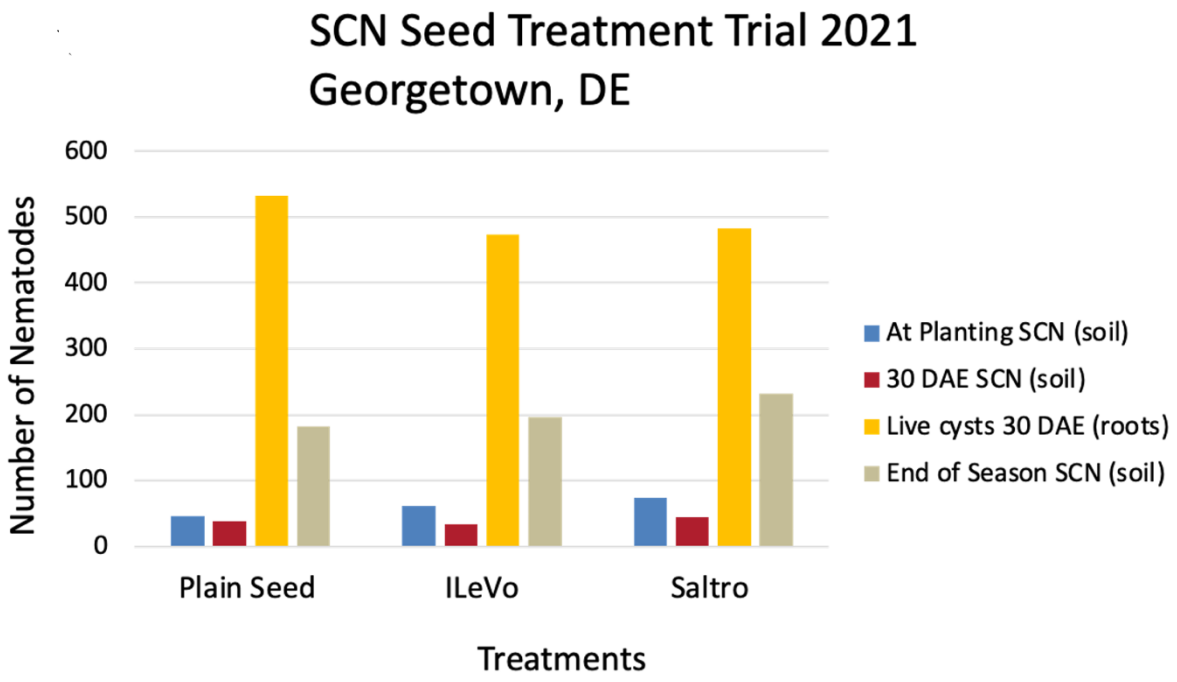

Figure 4: Differences in SCN counts at planting, 30 DAE, and at the end of the season.

Wye Mills, MD

This trial was planted later in the season and no differences in emergence were observed. Soybean cyst nematode recovery was lowest at the time of planting. Baseline SCN populations ranged from 0-200 juvenile nematodes per 500 cc soil with no difference in averages across each of the treatments and non-treated control. Within 30 days after emergence, populations were higher in all three treatments, including the control. Prior to harvest, no significant SCN population differences were present among treatments (Figure 5). In addition to soil samples, five plants per plot were dug up 30 days after emergence (DAE) to sample for SCN cysts via a root blasting protocol. No statistical differences in cyst number were observed and numbers were very low. No yield differences were present among treatments (Table 4). Further replications of this experiment will be conducted in 2022 to confirm preliminary results.

Table 4: Emergence and Yield Data from 2021 SCN seed treatment trial in Wye Mills, MD

Treatment	Yield (bu/a)
Plain Seed	72.1
Saltro	71.6
ILEVO	73.0
p-value	0.92

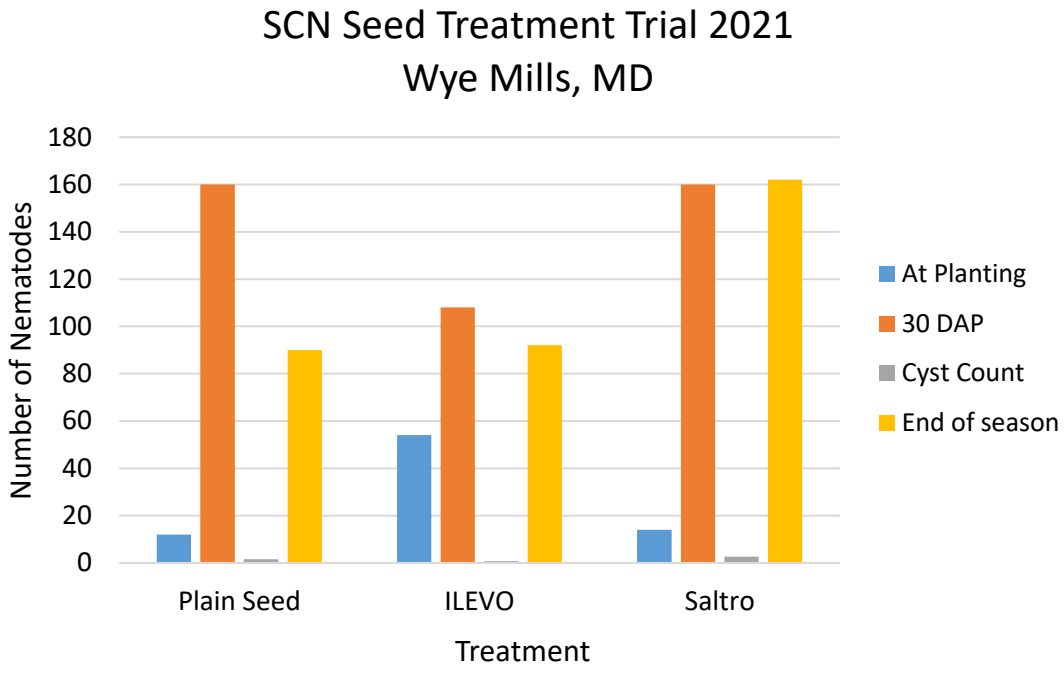

Figure 5: Differences in SCN counts at planting, 30 DAE, and at the end of the season.

References:

Allen TW, Damicone JP, Dufault NS, et al. 2018. Southern United States soybean disease loss estimates for 2017.

Mulrooney R., Gregory, N. 2010. 2009 Soybean Cyst Nematode Survey Results. UD Extension Bulletin #144, pp. 15-17.

Proposed Budget:

Graduate Student Stipend (30% of annual effort)	= $8,003
30% of Graduate Student Tuition	= $2101
Fringe Benefits 11.9%	= $952
Field Supplies	= $500
Nematode Samples (45 samples submitted to Nematode Assay Lab)	= $6,500
Travel for soil sample collection	= $1,526
Total Proposed Budget	**= $19,082**

Research Dissemination and ASC Recognition:

-August 19, 2021: UD Nematode Field Day
-November 16, 2021: Virtual Nematodes in Atlantic Soybean Production Webinar
-January 13, 2022: Delaware Ag Week, Virtual Soybean Session

Public Summary:

Soybean cyst nematode (SCN) (*Heterodera glycines*) is consistently ranked among the top destructive soybean pathogens across the United States and is the most significant nematode pest affecting soybeans in Delaware and the Eastern Shore of Maryland. This project aimed to build collaborations with farmers and survey nematode genera in soybean fields across the region. In total, 135 fields were surveyed. Soybean cyst nematode was present in 42% of fields, root knot nematode in 7%, and lesion nematode in 78%. Within SCN samples, 60% were over economic damage threshold, 7% for root knot, and 11% for lesion. Survey work was complimented by regional field trials in DE and MD to assess two seed treatment products, Saltro and ILEVO, versus non-treated seed for nematode control and yield effects. The MD location had low SCN pressure and no treatment differences were observed. Populations of SCN were higher at the DE location. In the earlier planted Georgetown trial, seed treatments increased speed and percent of germination. Yield response was not significant. The trial will be repeated in 2022 to compile additional observations. By hosting a nematode focused webinar, this project brought together researchers, individuals in industry, and farmers from DE, MD, PA, NJ, NY, and VA to engage in dialogue on improving understanding and management of nematodes within Mid-Atlantic soybean production.

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