2020 Final Report: Maryland Soybean Board
Efficacy of seed treatments to manage soilborne pathogens of soybean

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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). 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. As resistance from the PI88788 gene loses effectiveness, growers are in need of additional tools to manage nematode populations. Seed treatments are often discussed, but there is limited efficacy data for seed treatment performance in the Mid-Atlantic. A survey was conducted across DE and MD in 2019 that found SCN present in 57% of sampled fields. Among these locations, SCN was confirmed at a research field site planted in a nematode susceptible soybean cultivar. This field was used to screen seed treatment efficacy in 2020. Project objectives included: 1) Screen seed treatment products for efficacy to reduce soybean yield loss from soybean cyst nematode. 2) Assess seed treatment effects on field populations of soybean cyst nematode. 3) Share research findings through extension events and survey farmers regarding their concern towards SCN population increases and use of seed treatments. Two SCN seed treatments were compared to plain seed with no product applied to investigate advantages in stand, nematode populations, and yield performance. This project funded two months of support for a M.S. student focusing on diseases of soybeans along with soil samples to provide insight on the nematode species present and their relative abundance among plots following seed treatments. As we continue to deal with breakdown of resistance gene efficacy and subsequent increases in SCN populations, this project established the first year of local data on a new seed treatment product and facilitated education surrounding SCN management.

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 could be 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> 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 were set up in a randomized complete block design with five replications. Plots were 25 ft in length and 10 ft wide. After seed was planted, soybean seedlings were monitored for phytotoxicity, stand emergence, and disease throughout the duration of the trial. Plots were harvested at the end of the season using a small plot combine.

<u>Objective 2</u>. Assess seed treatment effects on field populations of soybean cyst nematode.

Within each of the 15 treatment plots, 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). Plots were assessed for nematode populations 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 to be processed. Population counts were provided for SCN, root knot nematode, lesion, lance, ring, spiral, and stubby root nematodes. In addition to soil samples, individual plants were dug from each plot 30 days after emergence to observe for SCN females (Figure 2). Roots were cut from the plant, gently washed to remove debris, and brought back to the lab for root blasting. Roots were held over a sieve set and female cysts were collected and counted under the microscope (Figure 3).

Figure 1: Collecting soil samples

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

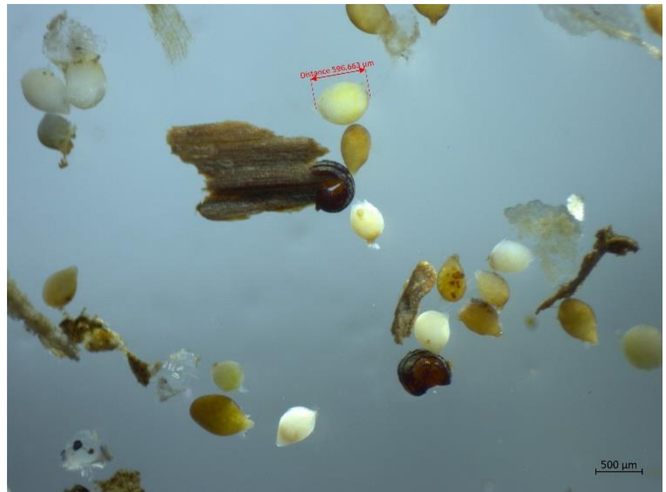

Figure 3: Cream to pale yellow colored SCN females under microscope magnification following root blasting.

Objective 3. Share research findings through extension events and survey farmers regarding their concern towards SCN population increases and use of seed treatments.

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 was also shared through training events and extension presentations such as Mid Atlantic Crop School, and the 2021 Delaware Ag Week. Due to COVID, in person field days could not be hosted in 2021, but video clips were prepared and shared through a virtual field day. The graduate student working on this project shared results at the Society of Nematology meeting held virtually in December 2020.

Results and Discussion:

Soybean cyst nematode was present in the field. Samples were submitted to characterize the nematode population in the field and it was identified as HG type 1.2, Race 2. This population was able to reproduce at a 65% rate on a line with the PI88788 resistance source (Table 1). Treated seed emerged faster and at a higher rate than non-treated plain seed (Table 2). Visual differences in canopy fullness and in end of season leaf senescence were also observed (Figure 4). 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.

Table 1: 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)	58	54	59	44	22%	+
2) PI 88788	129	155	164	184	64.8%	+
3) PI 90763	4	1	0	3	0%	-
4) PI 437654	0	0	0	0	0%	-
Pickett	113	168	154	131	58%	+

HG type: 1.2
Race: 2

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

Table 2: Emergence and Yield Data from 2020 SCN seed treatment trial in Georgetown, DE

Treatment	**% Emergence 18 DAP**	**% Emergence 28 DAP**	**Canopeo 9.20.20**	**Yield (bu/acre)**
Plain Seed	26.2 c	54.0 b	5.2	31.6
ILeVo	54.3 b	90.5 a	15.7	34.4
Saltro	70.0 a	86. 4 a	16.1	36.4
LSD (α=0.05)	11.9	6.3	ns	ns
p-value	0.0001	0.0001	0.19	0.55

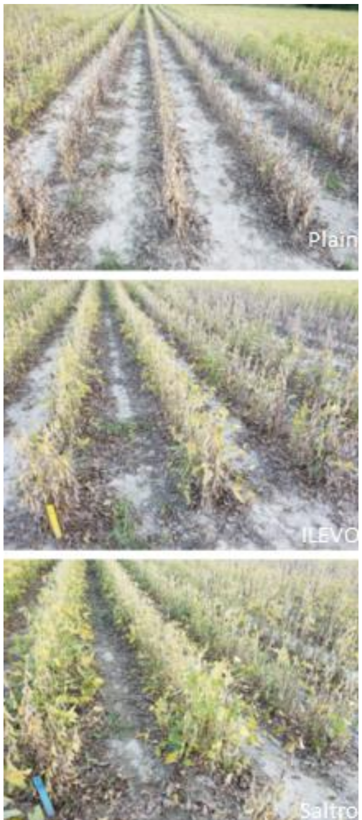

Figure 4: Visual differences among seed treatment plots.

Soybean cyst nematode recovery was highest at the time of planting. Baseline SCN populations ranged from 820-1000 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 declined in all three treatments, including the control, though Saltro populations were higher (582 SCN per 500 cc; p= 0.03) than ILEVO and non-treated plain seed. Five weeks prior to harvest, no significant SCN population differences were present among treatments. At this timing, populations increased in the non-treated plain seed and ILEVO treatment, but continued to drop across the Saltro treatment, to a season low average of 172 SCN per 500 cc. 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 treated plants were significantly lower (p=0.03) than those of the ILEVO and non-treated plain seed. In this trial, Saltro was the most effective at reducing cysts per plant and had the lowest numerical SCN populations at the end of the season. Further replications of this experiment will be conducted in 2021 to confirm preliminary results.

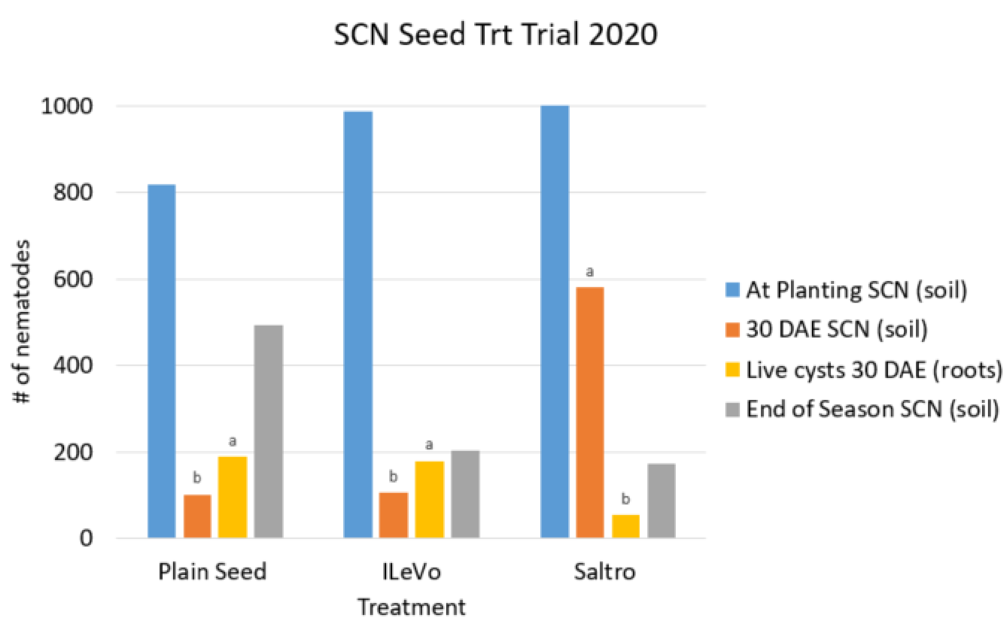

Figure 5: Differences in SCN counts at planting, 30 DAE, and at the end of the season.

References:

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

Beeman, A.Q., and Tylka, G.L. 2018. Assessing the effects of ILeVo and VOTiVO seed treatments on reproduction, hatching, motility, and root penetration of the soybean cyst nematode, *Heterodera glycines*. Plant Disease. 102: 107-113.

Gaspar, A.P., Mueller, D.S., Wise, K.A., Chilvers, M.I., Tenuta, A.U., and Conley, S.P. 2017. Response of broad-spectrum and target-specific seed treatments and seeding rate on soybean seed yield, profitability, and economic risk. Crop Science. 56: 2251-2262.

Proposed Budget:

Graduate Student Stipend (2 months)	=$4,975.27	
2 months of annual $26,677		=$4,446.17
Fringe Benefits 11.9%		=$529.10
Nematode Samples (45 samples submitted to Nematode Assay Lab)	= $900	
Total Proposed Budget	**= $5,878.27**	

Research Dissemination and MSB Recognition:

-November 18, 2020: Mid-Atlantic Crop School, Virtual

-Society of Nematology Poster, Virtual

-January 20, 2021: Delaware Ag Week, Virtual

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. SCN has been present in Delaware since 1979 prompting growers to rely on resistant varieties, primarily using the PI88788 resistance source. However, additional control strategies are needed as SCN populations have begun reproducing readily on these once resistant cultivars. A five-replication field trial was conducted in 2020 to evaluate two soybean nematicide seed treatments, ILEVO (fluopyram) and Saltro (pydiflumetofen), compared to non-treated plain seed, for stand emergence, control of SCN, and yield differences. Both seed treatments increased speed and percent of germination. Saltro treated plants yielded the highest, at 36.4 bushels per acre, but there were no statistically significant yield differences among treatments. In this trial, Saltro was the most effective at reducing cysts per plant and had the lowest numerical SCN populations at the end of the season. Further replications of this experiment will be conducted in 2021 to confirm preliminary results.

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