Delaware SOYBEAN BOARD

FISCAL YEAR 2022

RESEARCH REPORT

ADVANCING RESEARCH

Delaware Soybean Board Funds Research to Benefit Growers

The Delaware Soybean Board approved funding for six research projects in 2023, evaluating planting dates, weed and pest control, nutrient efficiency, and more. The total investment of $57,361 is funded through the soybean checkoff program to maximize soybean farmer's profitability in the First State.

"We consistently poll our farmer-leaders from across the state to identify challenges in soybean production," says Cory Atkins, Chair of the Delaware Soybean Board. "Using this information, we are able to select projects for funding that will provide the greatest benefit to the growers paying into the checkoff." - CORY ATKINS, DSB CHAIR

New Projects for 2023

- **Identifying and culturing slug parasitic nematodes in Delaware**, Dr. Michael Crossley, University of Delaware, $7,884
- **Soil pH and planting timing effects on yield**, Drs. Jarrod O. Miller and Amy L. Shober, University of Delaware, $6,356
- **Irrigation and starter potassium effects on uptake and yield**, Drs. Jarrod O. Miller, Alyssa Koehler, and Cory Whaley, University of Delaware, $5,650
- **Soybean Row Spacing and Planting Rate Effects on Litter Decomposition**, Dr. Jarrod O. Miller, James Adkins, and Dr. Cory Whaley, University of Delaware, $5,556
- **Evaluating Common Preemergence Herbicides for Relative Crop Safety**, Dr. Mark VanGessel, University of Delaware, $16,812
- **Case study testing effectiveness of deer repellents under extreme deer grazing**, Luke Macaulay, University of Maryland, $13,010

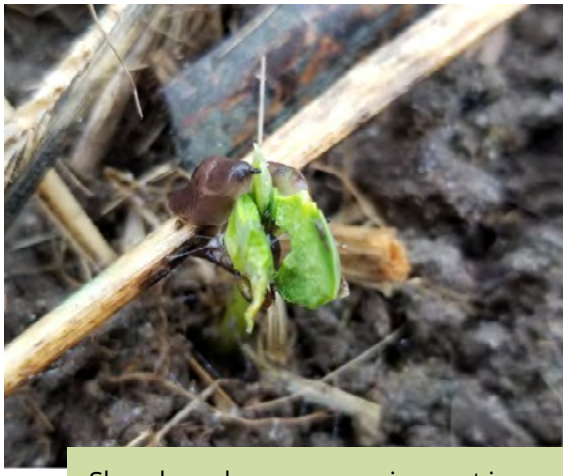
SUMMARIES IN THIS ISSUE

INSECTS & PESTS

Environmental factors promoting natural suppression of slugs in soybeans

Dr. Michael Crossley, University of Delaware

Slugs are a persistent threat to Delaware soybeans, typically infesting < 20% of soybean acreage but causing significant yield loss when populations reach high densities. The sporadic-but-severe nature of slug damage makes management frustrating. Ironically, insecticides make slug problems worse by killing predators but leaving slugs unharmed.



Slugs have become a major pest in no-till soybeans in the Mid-Atlantic. Photo: Cory Whaley, University of Delaware Extension

Molluscicides (e.g., metaldehyde or iron phosphate, applied as a bait) can be effective, but are too costly and prone to washing away with rain to be relied upon as a preventative treatment. By the time slug damage is evident, though, it may already be too late to achieve control with a molluscicide. Moving forward, we need to understand what factors put a soybean field at greater risk of economic damage by slugs so that we can manage our farms to avoid situations where stand loss becomes unacceptably high.

Natural predators and parasites (enemies) of slugs are a perhaps underappreciated ally in our battle against slugs. A variety of ground beetles, spiders, marsh flies, and nematodes are known to consume slugs at different parts of the slug life cycle. These natural enemies are themselves influenced by a number of factors, including weather, tillage, pesticide use, and cover crops.

Sometimes, the link between natural enemy numbers and slug numbers appears clear. For example, a common ground beetle (Pterostichus melinarius) readily consumed a common slug (Deroceras reticulatum) in a small grains farm in the UK, and slug numbers dropped with increasing beetle numbers. However, for most natural enemies, such detailed knowledge about how slug numbers change with increasing enemy densities is lacking. Furthermore, how the overall suppression of slugs by natural enemies varies with weather, landscape, and management factors in Mid-Atlantic soybean is uncertain.

This project addressed this uncertainty by identifying the natural enemies most often found attacking slugs in soybean and examining environmental factors associated with higher suppression of slugs by natural enemies.

Dr. Crossley and his team sampled thousands of ground-dwelling predatory arthropods (beetles and spiders) from Delaware soybean fields where they co-occurred with slugs. The majority (80%) of these predatory arthropods were ground beetles, and 15 species were identified that could be potential slug predators. Future work will determine which of these are the most impactful on slugs and how they can promote them on the farm.

They found that 3% of slugs captured in the field were infected with nematodes. They have so far identified one species from these nematodes that is mildly pathogenic against slugs and plan to continue the search for highly pathogenic nematodes that could be used for biocontrol of slugs. Using two years of slug and predator counts from corn and soybean fields representing a diversity of management practices (no-till, reduced-till, preplant insecticides use, cover crops or bare ground), they found evidence to confirm that tillage reduces slugs, even after cover crops provided some benefit to slug populations. They also found that cool and wet conditions were favorable for slugs. Importantly, they found that ground beetles decreased slug numbers in the field. Ground beetles also appeared to be harmed to an extent by the use of preplant insecticides. Altogether, results suggest that practices that promote ground beetles could counterbalance effects of no-tillage and cover crops on slugs.

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NEMATODES

Visualization of Economic Damage Thresholds and Interaction of Nematode Populations following use of Winter Cover Crops

Dr. Alyssa Koehler, University of Delaware

In rhizobox trials, effect of SCN and RKN on reduced growth and pod set were visualized and optimizations to the rhizobox system will be made to continue to develop photo and video resources at varying nematode population levels.

Soybean cyst nematode (SCN) (Heterodera glycines) and Root knot nematode (Meloidogyne spp.) consistently rank as top destructive pathogens of soybeans (Glycine max (L.) Merrill) across the United States. In surveys conducted across Delaware and Maryland from 2019-2021 SCN and RKN were widely prevalent across the state, particularly in Sussex County.

Nematodes often go undiagnosed, but can be very damaging to soybean production reducing both yield and quality. Visualizing stunting and other silent symptoms can assist recognition of unnoticed yield impacts.

The PI88788 resistance gene once effectively managed soybean cyst, but populations are now able to reproduce at high levels, reducing the effectiveness of this resistance source. Growers are in need of additional tools to manage nematode populations and often ask questions about the impact of cover crop decisions on nematode populations.

Growth of soybean plants and roots inoculated with soybean cyst nematode (left), root-knot nematode (center) and no nematodes (right) Photo: Alyssa Koehler, University of Delaware

Project objectives included:

1. Utilize rhizoboxes to visualize economic damage thresholds for Soybean Cyst Nematode (SCN), Root Knot Nematode (RKN), and the interaction of SCN and RKN.
2. Track in-season nematode populations following the use of winter cover crops.
3. Share research findings through extension events and use findings to inform future management trials.

In rhizobox trials, effect of SCN and RKN on reduced growth and pod set were visualized and optimizations to the rhizobox system will be made to continue to develop photo and video resources at varying nematode population levels.

Nematode soil samples were collected from different cover crops to provide insight on the nematode species present and their relative abundance among plots after winter cover crops.

No notable nematode populations were recovered in any of the plots in the spring, fall results are pending analysis and final conclusions will be updated upon their arrival.

Scan the QR code to learn more about this project.

AGRONOMY

Evaluating Earlier Planting Dates for Increased Soybean Yields

Drs. Jarrod O. Miller, Alyssa Koehler, and Cory Whaley, University of Delaware

The start of indeterminate soybean reproductive stages depends on the detection of the length of night. As nights become longer, soybeans are triggered to begin the reproductive or "R" stages of maturity. Due to this, later planted beans do not have as much time to develop biomass, or leafy growth. Additional photosynthesis from leaves and nodes for pod production can mean additional yield with more time to grow.

However, issues with earlier planting have occurred where cooler, wetter soils slow germination. This may cause seeds to rot in the ground. Additionally, sudden death syndrome (SDS) infects soybean roots of earlier planted varieties, but won't be noticed until later in the season. With newer varieties, it is necessary to evaluate the limits of planting earlier in Delaware, and determine if additional yield is outweighed by other biotic and abiotic factors.

To assess this, Dr. Miller and his team planted full season soybeans on three different dates (early, mid, and late), evaluated the soybean plots for deficiencies and disorders, and compared tissues and soil contents to yield at the end of the season.

Untreated group IV soybean seeds were planted at the Carvel Research and Education Center on April 13th, 26th, and May 11th, 2022. Despite freeze damage to the April 13th planting, yields, were similar across all treatments, ranging from 67 to 68 bushels per acre.

Tissue and soil samples were taken at the R2 growth stage, and almost all nutrients had some differences based on planting timing. However, all nutrients were within sufficiency ranges, despite having different concentrations based on planting timing. Although each treatment was planted two weeks apart, tissue sampling occurred within one week. This is because most studies reached R1/R2 at similar Julian dates, since the 1st planting would have slower early growth with cooler weather.

Only Ca was borderline deficient in the tissue and was also lowest for the May 11th planting date. While S was not deficient, it was on the lower end of sufficiency ranges. Sulfur dropped in the soil with later planting but was higher in the tissue. Since most soil samples were taken at similar time points, this may represent plant uptake more than leaching from the profile. The nutrients P, K, Mg, Zn, and Fe were all higher with earlier planting dates, but B (like Ca and S) was highest in the tissue from the last planting date.

Like the 2020 and 2021 study of planting timings, Al concentrations were lower in the tissue with later plantings, with a pH relationship only occurring during the earliest planting. The uptake of Al within soybeans can be variety or pH related, but in all three years has certainly been planting date related.

So, while planting date can influence tissue concentrations of nutrients, it may only matter when fertility is lacking, or an antagonistic relationship occurs. This could include drought conditions, which were not evaluated in this study. Currently, they would not recommend any variation in soil fertility based on planting date, but antagonistic relationships with Al uptake should be studied.

While planting date can influence tissue concentrations of nutrients, it may only matter when fertility is lacking, or an antagonistic relationship occurs.

Planting date timing study trials at the University of Delaware Carvel Research Center are answering farmer questions and raising new ones about soybean growth patterns and nutrient uptake. Photo: Jarrod Miller, University of Delaware

Scan the QR code to learn more about this project.

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Soybean row spacing appears to influence the rate of residue breakdown on the soil surface. The volume of residue in the 15-inch rows on the left is noticeably less than in the 30-inch rows on the right. Photo: University of Delaware Extension

While yields and biomass decomposition could not be related to population and row spacing, and therefore canopy cover, some differences did arise related to overall soybean yields.

CROP MANAGEMENT SYSTEMS

Soybean Row Spacing and Planting Rate Effects on Litter Decomposition

Dr. Jarrod O. Miller, University of Delaware

Cover crops have been rapidly adopted in Delaware, with cereal rye being a popular option for soybean production. The benefits of a rye mulch is weed suppression and soil moisture conservation, but may also cause increased pest presence and disrupt the release of nitrogen (N) to cash crops.

While soybeans may not be as affected by the N cycle as corn, the mineralization and release of N in rye may also provide supplemental N to the plant mid-season. These fields may also include corn fodder from the previous cropping year, which will continue to breakdown through the soybean growing season, providing some carbon the soil surface. What is not currently known is how soybean populations and row spacing may affect the decomposition of residues on the soil surface.

Earlier canopy may preserve soil moisture, allowing for increased residue decomposition, or may increase evapotranspiration reducing overall soil moisture. This study will take the first steps in measuring decomposition of residues under soybean planting densities.

To complete the study, Dr. Miller planted full season soybeans into a rye cover crop at five populations and two row spacings, then used decomposition bags to measure breakdown of corn fodder and rye biomass under different soybean management systems.

Compared to the companion study on population and row spacing performed at University of Delaware's irrigation research farm in 2022, no differences in yield were observed.

Some of this can be related to issues at planting, which included planter by rye biomass as well as potential seed germination. The drone derived NDVI values show that the errors mostly reside in the 15-inch 150,000 and 180,000 seeding treatments.

While yields and biomass decomposition could not be related to population and row spacing, and therefore canopy cover, some differences did arise related to overall soybean yields.

The 15-inch row spacing mostly caused decreases in corn C/N ratios by the end of the season, which may have been more consistent had the correct canopy cover occurred. That rye breakdown was greater in higher yielding plots, where yields were also related to higher NDVI (canopy cover) in August could still support the original hypothesis. Still, the study needs better controls on actual growth by treatments to observe if these are related.

Additionally, there is a relationship with corn fodder decomposition when the rye that is present. Where more C was remaining in the rye biomass, the corn fodder decomposition was higher. This study cannot show the mechanism that drove this result, which could be related to biological activity that preferred corn decomposition over rye, or could point to an interaction of fresh rye biomass with corn fodder. The bags are not conducive to larger detritovores which could have also helped with fodder breakdown. As rye decomposition leads to lower C/N ratios, and is related to higher soybean yields, corn fodder appears to prefer the opposite environment, at least during the period of this study. A repeat of this study in 2023 may help further elucidate the relationship.

WEED CONTROL

Management of Herbicide Resistance in Palmer Amaranth

Dr. Naveen Dixit, University of Maryland Eastern Shore

Palmer amaranth (Amaranthus palmeri) is a major weed in soybean cultivation across the state. In recent years, these weeds have become resistant to multiple herbicides (acetolactate synthase, photosystem II, and protoporphyrinogen oxidase etc.) including glyphosate (ESPS synthase inhibitor). Glyphosate is one of the most widely used herbicides in soybean cultivation (97%) in the USA due to its high efficacy, low toxicity, and low environmental impacts. However, excessive reliance on glyphosate leads to faster evolution of herbicide resistance (HR) in Palmer amaranth. Other causes are poor management practices, inadequate doses, and wrong application timings. This man-made evolution poses a serious threat to food security in term of yield losses up to 79%. HR is inevitable, but can be slowed down using multiple technologies. This study evaluated the induction of non-target site resistance in Palmer Amaranth due to current applications of herbicides in Delaware. This work will help to decide what combination of herbicides will slow the evolution of HR in soybean cultivation.

It is evident that the use of herbicides with single mode of action must be avoided while a mixture application is beneficial to slow down the occurrence of non-target site resistance in Palmer Amaranth.

Non-target-site herbicide resistance was evaluated in commercially available herbicides labeled for the management of Palmer Amaranth (Amaranthus palmeri). Eight treatments were used with recommend rates as per label:

- T1: Control
- T2: Flexstar (22.1%)
- T3: Buccaneer 5 Extra (53.8%)
- T4: Flexstar (5.88%) GT3.5 with Glyphosate (22.40%)
- T5: Defy LV-6 (88.4%): 2,4-D
- T6: Enlist Duo (Glyphosate: 22.1% + 2,4-D: 24.4%)
- T7: Dicamba
- T8: VISOR S-MOC (83.7%)

Palmer Amaranth leaf samples were exposed to herbicides in petri dishes in laboratory conditions followed by incubation in distilled water for 1 hour. Photo: Naveen K. Dixit

Glutathione-S-Transferase (GST) and Glutathione Reductase (GR) activity was determined in leaf samples in all the treatments after 15 minutes of exposure in herbicides followed by incubation in water for 1 hour.

GST activity was the highest in glyphosate treated leaves and followed by Glyphosate > Fomesafen > Fomesafen + Glyphosate > 2,4-D > Dicamba > 2,4-D + Glyphosate > Metolachlor. The lowest GST activity was observed in T6 (2,4-D + Glyphosate) and T8 (Metolachlor).

Levels of GST were higher in herbicide treatments with single mode of action except T8 (Metolachlor) while lower in herbicide treatments with more than one mode of action. Treatments with lower levels of GST can slow down the evolution of non-target-site resistance in comparison to treatments with higher GST levels. Higher GR levels were also associated with the lower levels of GST except in T8 (Metolachlor).

Based on these findings, it is evident that the use of herbicides with single mode of action must be avoided while a mixture application is beneficial to slow down the occurrence of non-target site resistance in Palmer Amaranth.

INSECTS & PESTS

Evaluating Deer Preferences for Soybean Varieties and Soybean Response to Deer Herbivory

Dr. Luke Macaulay, James Lewis, and Dr. Nicole Fiorellino, University of Maryland

Deer are the leading cause of crop damage by wildlife in Delaware. Delaware in particular faces greater challenges than many other soybean growing areas in the country due to smaller field sizes that are more often interspersed with and bordered by forested areas that provide refuge for deer, which emerge to graze highly palatable and nutritious soybeans. While hunting and crop damage permits allow some farmers to reduce deer population densities, some locations are not amenable to this due to factors such as landowners or neighbors that do not allow hunting, nocturnal grazing activity, and time required to harvest sufficient numbers of deer.

Deer feeding in forage soybean trial fields. Photo: Luke Macaulay

Ongoing research has provided baseline information about the applicability of using various varieties of forage soybeans as a diversion crop around a field perimeter to reduce damage to core growing areas. This project continued that work to gain deeper understanding across a second growing season by continuing to assess 1) yield by different forage soybean varieties and 2) deer activity and preferences of these varieties. This year's work added to the project by 1) conducting regular forage analyses across the growing season to discern whether deer prefer certain varieties at certain times; 2) conducting a manual defoliation experiment to better understand soybean plant response to herbivory, and 3) providing a greater quantity of demonstration seeds to farmers and assessing their qualitative and quantitative observations about the practice.

After 3 years of work on forage soybeans, Dr. Macaulay recommends different approaches to using soybean buffers depending on a few factors, especially focused on herbicide traits, and timing of hunting programs.

After 3 years of work on forage soybeans, Dr. Macaulay recommends different approaches to using soybean buffers depending on a few factors, especially focused on herbicide traits, and timing of hunting programs.

Because deer did not appear to prefer any soybeans over another, his recommendation is to focus on high-biomass producing soybeans that will feed a greater number of deer. In 2023, it was found that a conventional Pioneer group 5.3 soybean, was able to match Eagle Seed's Big Fellow forage soybeans in biomass production.

If a farmer has weed issues that require herbicides beyond glyphosate, they should consider a conventional group 5 soybean, which can produce high biomass, be resistant to additional herbicides, and produce a high yield.

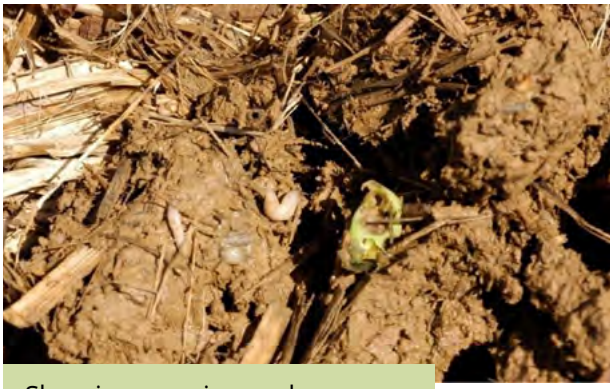
If a farmer is interested in using a soybean buffer as part of a lethal control or hunting program that includes a heavy focus on early hunting in September, they should consider the latest maturity group variety available. In the soybeans studied, Eagle Seed has a high biomass producing forage soybeans that will stay green partway into the second half of September which aligns with the early archery hunting season in many places, and may draw deer into the field for that.

If farmers want to use an unharvested soybean buffer as a food-plot attractant for a lethal control or hunting program later in wintertime and are not interested in early season hunting, they should consider a group 5 high-yielding and high-biomass-producing conventional soybean.

If a farmer is interested in hunting in both early season and late season, and glyphosate tolerant varieties are sufficient, they should consider a mix of conventional and forage soybeans to achieve green forage in the early season, and a good yield of soybeans in winter.

Scan the QR code to learn more about this project.

Slug populations are favored by no-till environments and emerged in the 1980's as major pests of both field corn and soybean.



Slugs in emerging soybeans.
Photo: University of Delaware

Scan the QR code to learn more about this project.

INSECTS & PESTS

Cover Crop Selection and Termination Implications for Slugs

Dr. David Owens, University of Delaware

Slugs are a perennial threat to between 10 and 20% of Delaware soybeans, depending on the year and weather conditions. Slugs are most problematic in no-till fields with high residue, especially in years with mild winters and cool, wet springs. Slug feeding can be severe enough to require replanting.

Remedial chemical management of slugs is difficult due to application cost, equipment requirements, and uncertainties regarding timing and necessity. By the time serious slug damage to a soybean stand becomes noticeable, it is unlikely that a bait application will be able to rescue enough of the stand to prevent a replant. Thus, preventative or cultural management strategies need to be developed and refined for slug management.

There has been a heavy emphasis over the last several decades to improve soil health by reducing soil disturbance and implementing cover crops. Slug populations are favored by no-till environments and emerged in the 1980's as major pests of both field corn and soybean. However, reduced tillage and cover crop presence also favors slug natural enemies.

Previous studies have shown variations in the differences of cover crop palatability and slug survivorship, inconsistencies with slugs and cover crops, and cover crop termination methods and timing. This study built on research completed by Dr. Owens the prior year, evaluating factors on a local level to examine potential influences between cover crop species and slug populations, as well as the impact of vertical tillage impacts on slugs.

In year 1 of the project, different cover crop species were sown in large plots on cooperator farm fields. No significant slug populations were detected in the various species plots. Plots were re-seeded in Fall 2022 to see if populations will increase gradually overtime.

Delaware SOYBEAN BOARD

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