Delaware SOYBEAN BOARD

FISCAL YEAR 2024

RESEARCH REPORT

The Delaware Soybean Board approved $48,248 in research funding for 2024, supporting ten projects aimed at improving soybean production right here in the First State. These efforts are focused on the real-world challenges Delaware growers face — from boosting yields to fine-tuning management practices that make a difference in the field.

“These research projects are built with Delaware farmers in mind,” said Tim Rogers of Frankford, current Chair of the Delaware Soybean Board. “By focusing on the conditions and concerns we see locally, we’re making sure checkoff dollars are used for practical, on-the-ground solutions that help growers succeed. It’s not just about this year’s crop — it’s about long-term sustainability and profitability.”

Led by researchers from across the region, the projects reflect the Board’s ongoing commitment to science-based solutions. From tackling herbicide resistance to studying how soil pH and planting timing impact yields, the work covers a range of important topics aimed at supporting a stronger future for Delaware soybean production.

Approved projects:

- **Assessment of Non-Targeted Site Herbicide Resistance in Palmer Amaranth** – Naveen Kumar Dixit
- **In-Season Reproduction of Root Knot Nematode** – Dr. Alyssa Koehler
- **Evaluating Common Preemergence Herbicides for Relative Crop Safety (Year 2)** – Mark VanGessel
- **Soybean Row Spacing and Planting Rate Effects on Litter Decomposition** – Jarrod O. Miller
- **Soil pH and Planting Timing Effects on Yield** – Jarrod O. Miller and Amy Shober
- **Best Planting Management for Double-Crop Soybeans in Delaware** – Jarrod O. Miller
- **Continued Identification and Culturing of Slug Parasitic Nematodes** – Dr. Michael Crossley
- **Do Micronutrient Fertilizers Help Reduce Herbicide Injury and Impact Weed Control** – Mark VanGessel
- **Texture Analyses of Grid Samples Under Center Pivot** – Jarrod O. Miller
- **Soybean Yield Response to Biologicals** – James Adkins INSECTS & PESTS

Texture Analyses of Grid Samples Under Center Pivot

JARROD MILLER (UNIVERSITY OF DELAWARE)

Table 1: Correlation Table of Nutrient Availability with Sand, Silt and Clay
Content: pH, Phosphorous, Potassium, Calcium, Magnesium, Manganese, Zinc, Copper, Iron, Boron, Sulfer, Sodium and Aluminum.

	pH	Phos	K	Ca	Mg	Mn	Zn	Cu	Fe	B	S	Na	Al
Sand	–	–	-0.50	-0.33	-0.47	-0.31	–	–	-0.23	-0.29	-0.16	0.13	-0.22
Silt	0.29	-0.14	0.41	0.37	0.34	0.18	–	0.21	0.22	0.35	–	0.02	-0.14
Clay	-0.26	–	0.35	0.13	0.38	0.30	–	-0.22	0.13	–	0.35	-0.23	0.52

The analysis of soil texture correlations with various nutrients and elements in coastal plain soils provides significant insights into the interactions between particle size and nutrient availability.

This study explored how soil texture (sand, silt, and clay) affects nutrient availability in Delaware coastal plain soils, which can vary due to topographic differences. Sandy soils, possibly remnants of old sand dunes in this area, generally have lower nutrient retention capacity. These soils are more prone to nutrient leaching and may require more frequent fertilization to maintain adequate nutrient levels. In contrast, soils with more silt and clay, typically found in lower areas or depressions, have a better ability to retain nutrients, providing a more stable environment for plant growth.

These lower landscape positions may have higher clay content due to erosion, deposition, or weathering from greater water presence. As a result, these areas also contained higher amounts of aluminum (Al) and organic matter, both associated with clay and lower landscape positions. As expected, pH and buffer pH were linked to clay content across the field, where clay's higher buffering capacity typically leads to more acidic conditions.

Silt-rich soils may have originated from loess, which also contributes to better nutrient retention. Micronutrients like manganese and copper were more available in finer soils (silt and clay) due to their higher nutrient-holding capacity. These micronutrients may also be related to the parent material itself, further enhancing micronutrient content. Zinc, however, did not show a clear relationship with soil texture, suggesting that other factors, such as past management practices, could influence its availability.

Understanding how soil texture, elevation, and parent material affect nutrient availability can help farmers optimize fertilization practices, manage pH levels, and improve overall soil health. This knowledge can lead to better crop productivity and more sustainable farming practices.

Soybean Yield Response to Biologicals

JAMES ADKINS (UNIVERSITY OF DELAWARE)

Figure 1: Soybean Yield By Treatment
Note: Yield differences not statisitically significantly.

	Soybean Yield Dry Bu/Acre	
	Rainfed	**Irrigated**
Control	31.6	72.6
Terramar V4	26.6	71.3
Terramar R1	25.0	69.0
Terramar V4 & R1	33.8	76.2
Utrisha N	23.6	78.3
Utrisha P	24.6	69.5
Dextrose	29.3	68.9
Humic	29.7	70.0
Upshift C & Redline	30.9	70.7
Ethos Elite 6oz	30.9	70.2
Zironar 6oz	29.8	71.9

This study demonstrated no yield benefit from using biological products under the tested conditions. Although none of the products hurt yields, none of the products showed a statistically significant impact on yield. Given these findings, farmers are unlikely to achieve positive returns from these products, even if they are cost-free. Results suggest that the efficacy of biological enhancements remains highly dependent on specific environmental conditions and cannot be generalized across broader applications.

Research across the U.S. has shown that biological products may enhance plant function and improve corn yields in specific soil types. Similarly, applications of carbon and other microbe "food sources" are theorized to stimulate native soil biology and produce comparable yield gains. This study evaluated the yield impacts of in-furrow and foliar-applied biological and supplemental products in coastal plain soils. Eight products (one with varied application timings) for a total of 10 treatments were tested in randomized 600-foot strips using a 6-row JD 7200 planter equipped with an in-furrow liquid application system.

Table 1: Field Operations, nutrient and pesticide applications.

April 24	VRT Dry Spread	Potash & MAP	0-315lbs/a
May 16	Pre-emerge Herbicide	Broadaxe & Metribuzin	22oz/ac
June 12	Plant 6 row JD 7200	Axis 4513E	140k seeds/a
June 19	Post-emerge Herbicide	Gly & Liberty	32oz/a
June 19	Early Foliar Application	Terramar + Radiate	1qt/a
July 2	Late Foliar Application	Terramar + Radiate	1qt/a
October 7	Corn Harvest Gleaner K2		

No statistically significant differences in yield were observed between treatments under either irrigated or rainfed conditions. Average yields were 28.7 bushels per acre on rainfed plots, and 71.7 bushels per acre on irrigated plots. The 2024 growing season was unusually dry, requiring 10.5 inches of supplemental irrigation. Aerial imagery confirmed high stress in rainfed areas, but no visual or yield distinctions were observed between treatments.

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Soybean Row Spacing and Planting Rate Effects on Litter Decomposition

JARROD MILLER (UNIVERSITY OF DELAWARE)

This study aimed to examine how row spacing, population density, and residue type affect soybean yield, biomass loss, and carbon-to-nitrogen (C:N) ratios in both irrigated and rainfed conditions. With a focus on rye and corn residues, it also sought to understand how these factors influence nutrient cycling and residue decomposition, key processes for maintaining soil health and optimizing future crop production.

The research was conducted at the Carvel Research and Education Center in Georgetown, DE. Irrigated soybean were planted in experimental plots with five seeding rates (80,000–160,000 seeds per acre) and two row spacings (15-inch and 30-inch). An additional rainfed field was planted off-site. Residue from a terminated rye cover crop and corn fodder was collected and placed in decomposition bags to track changes in biomass, C:N ratios, and decomposition over the season.

This project was replicated for a third year in 2024. In both 2022 and 2023, findings showed a 10-bushel yield advantage for narrower row spacing (15" vs. 30"), a 25-bushel increase with irrigation, and no significant differences between seeding rates ranging from 90,000 to 180,000 seeds per acre.

Soybean yields were not significantly influenced by either row spacing or population density in both conditions, marking a shift from previous years where narrower row spacing had provided a yield advantage.

For biomass loss, rye and corn residues showed different decomposition patterns. Rye residue decomposition was more influenced by population under irrigated conditions, with denser canopy leading to greater breakdown. Corn residue decomposition was impacted by row spacing, with 30" rows under rainfed conditions causing greater loss, but mostly at higher populations.

The C:N ratios of both rye and corn residues were generally unaffected by population density. However, irrigated row spacing had a significant impact on rye C:N ratios in irrigated fields, with narrower rows resulting in a lower ratio, suggesting faster decomposition. While rye residues, with their higher initial C:N ratio, decomposed more quickly, corn residues maintained a higher ratio throughout, indicating slower breakdown. These results highlight the complex interactions between environmental conditions, row spacing, and population density in influencing residue decomposition and nutrient cycling.

Soil pH and Planting Timing Effects on Yield

JARROD MILLER (UNIVERSITY OF DELAWARE)

In the Mid-Atlantic region, soybean yields usually show little difference between April- and May-planted crops. However, earlier planting may expose soybeans to cooler temperatures and increased disease, which could lower yields. Research on double-cropped soybeans suggests that aluminum (Al) and iron (Fe) uptake negatively impacts early-planted crops. Raising soil pH with lime can reduce the solubility of Al and Fe, potentially benefiting coastal soil producers by extending the growing season. However, higher pH may reduce availability of micronutrients like manganese (Mn), zinc (Zn), copper (Cu), and increase leaching of boron (B) and sulfate (SO4).

Plots in early summer at the Carvel Research and Education Center.

This study aimed to evaluate the effects of different liming rates and planting timings on soybean yield and nutrient uptake using dolomitic lime. It was performed at the Carvel Research and Education Center in Georgetown, DE, with two factors: liming rate (0, 0.25, 0.5, 0.75, and 1.0 tons per acre) and planting timing (April 9, 2024 and May 29, 2024). The lime was dolomitic based on soil testing prior to application. Soil and tissue samples were collected at V3 and R3 growth stages to assess nutrient levels.

Yield results showed no significant differences among liming rates, with yields ranging from 56.27 to 64.14 bu/ac. The highest yield (64.14 bu/ac) was recorded at the 0.75 tons/acre lime rate, and the lowest (56.27 bu/ac) at 0.5 tons/acre. However, planting timing significantly affected yield, with soybeans planted in April yielding 62.67 bu/ac compared to 54.74 bu/ac in May, likely due to warmer weather conditions in April.

Soil nutrient concentrations varied with liming, showing significant changes in calcium, pH, magnesium, boron, and base saturation. Calcium and magnesium increased with dolomitic lime rates, while phosphorus, manganese, zinc, copper, iron, sulfur, and sodium did not change significantly. Aluminum (Al) and iron (Fe) decreased with lime, supporting the idea that liming reduces the solubility of these metals in coastal soils.

For leaf tissue, micronutrient availability decreased with higher lime rates, particularly for manganese (Mn), zinc (Zn), and boron (B), both in soil and tissue. In soil, Mn, Zn, and B levels declined with increasing lime rates, especially at 0.75 tons/acre (where pH > 5.8). Similarly, V3 trifoliate tissue concentrations of Mn, Zn, and B were highest at the 0 and 0.25 tons/acre lime treatments, with a steady decline as lime rates increased. Soybeans planted in May had higher Mn and Zn concentrations compared to those planted in April, while B followed a similar, but less consistent pattern. These results suggest that excessive liming reduces the availability of these essential micronutrients, potentially affecting soybean growth when soil concentrations are deficient.

From V3 to R2, nitrogen (N), phosphorus (P), and potassium (K) concentrations declined more in April-planted soybeans, while Mn and B increased more in May-planted soybeans. Iron and aluminum concentrations decreased more in May-planted soybeans. These shifts did not negatively affect early-planted soybeans, which yielded better.

Overall, soybean yield was not significantly affected by liming rate but was higher with earlier planting, due to warmer than normal conditions. Liming had minimal effects on macronutrient availability, except for increases in calcium and magnesium in the soil. Higher lime rates reduced Mn, Zn, and B availability, which may limit growth. These findings suggest that early planting remains beneficial for yield, and liming effects on nutrient uptake were relatively minor for the rates applied. A pH higher than 5.8 may have caused greater issues.

In-Season Reproduction of Root Knot Nematode

ALYSSA KOEHLER BETTS (UNIVERSITY OF DELAWARE)

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.

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

Continued Identification and Culturing of Slug Parasitic Nematodes In Delaware

MICHAEL CROSSLEY (UNIVERSITY OF DELAWARE)

Slugs pose a recurring threat to Delaware soybean production, affecting less than 20% of fields but causing substantial yield losses when present in high numbers. Their unpredictable and severe damage makes management difficult. Ironically, insecticides can worsen slug issues by eliminating predators while leaving slugs untouched. Though molluscicides (like metaldehyde or iron phosphate) may work, they are costly, susceptible to rain, and often applied too late for effective control. Understanding which field conditions heighten slug risk is critical to improving management strategies.

Natural enemies—including ground beetles, spiders, marsh flies, and nematodes—can help suppress slug populations, though their effectiveness is shaped by weather, tillage, pesticide use, and cover crops. For example, a common ground beetle readily consumed a common slug in a small grains farm in the UK, and slug numbers dropped with increasing beetle numbers. However, it is unclear how farms can leverage these natural enemies.

With funding from the Delaware Soybean Board, Dr. Crossley began investigating natural enemies of slugs and the conditions that support them. In 2023, 17 fields were sampled in Delaware and Maryland, yielding a total of 1,531 slugs (1,043 marsh slugs, 488 gray garden slugs). Captured slugs were reared in the lab for three weeks under optimal conditions to encourage the emergence of parasitic nematodes. Infected slugs will “melt,” releasing nematodes, of which three species were identified. to continue identifying nematode species and conduct pathogenicity tests to evaluate their potential as effective biological control agents against slugs.

This project was replicated in 2024, collecting 363 gray garden slugs and 321 marsh slugs from 15 fields in Delaware and Maryland between April and June 2024. Of those, 43 gray garden slugs and 65 marsh slugs (combined 15% of total slugs) were infected with slug-parasitic nematodes. At the time of this report, identification of these nematodes to species using morphological and DNA sequence characteristics was still underway. Dr. Crossley and his team also learned a great deal about maintaining nematodes in the lab and are well-positioned to begin experiments to test our nematodes’ pathogenicity against slugs.

Best Planting Management for Double-Crop Soybeans in Delaware

JARROD MILLER (UNIVERSITY OF DELAWARE)

Double-cropping, where soybeans are planted after a winter small grain crop like wheat, is a common practice in the Mid-Atlantic region. The longer growing season and the ability to grow winter grains make this practice especially beneficial. However, optimizing planting methods for soybeans can help improve yields. In southern Delaware, we tested a range of planting populations, from 40 to over 180 thousand plants per acre, along with two row spacings—15 inches and 30 inches between rows. These combinations were evaluated to see how they influenced soybean yield under double-cropping conditions.

For planting population, the results showed that higher planting populations (greater than 120 thousand seeds per acre) produced higher yields. While all populations (from 40 to 180 thousand plants per acre) had some impact on yields, the densest plantings consistently outperformed the lower populations. This suggests that increasing the number of plants per acre helps optimize soybean growth and improve yields in double-cropping systems. For row spacing, narrower rows (15 inches) resulted in better yields compared to wider row spacing (30 inches). Soybeans planted in narrower rows had better sunlight exposure and more room to grow, which enhanced plant development and overall productivity.

For double-cropped soybeans in the Mid-Atlantic, increasing planting population beyond 120 thousand seeds per acre and using 15-inch row spacing are key practices for boosting yields. While lower populations (down to 90 thousand plants per acre) have maintained yields in irrigated, full season systems, double crop requires higher populations. These recommended planting rates are still lower than previous University recommendations for our region.

Sand, silt, and clay content mapped across the Warrington Irrigation Research Farm. Light colors are more sand, while dark black is higher silt, and dark red is greater clay.

Do Micronutrient Fertilizers Help Reduce Herbicide Injury and Impact Weed Control?

MARK VANGESSEL (UNIVERSITY OF DELAWARE)

As herbicide-resistant weeds become more common, farmers often rely on additional herbicides, which can compromise crop safety. Nutritional and microbial additives are being marketed to improve crop safety and weed control, but there is little university research available to guide farmers on their effectiveness.

To address this gap, Dr. Mark VanGessel at the University of Delaware conducted a study to evaluate whether micronutrient fertilizers added to postemergence herbicides could reduce soybean injury or influence weed control. The research also examined crop safety across different herbicide combinations and planting dates.

In a field trial conducted in Georgetown, Delaware, soybeans were treated with two herbicide programs: Reflex + Basagran + Select Max and Roundup PowerMax3 + Liberty + Enlist One. Each of the herbicide treatments was applied without fertilizer additives, PhosFix, Microplex, ENC Flex, or sucrose. Overhead irrigation was supplied as needed. Crop injury and weed control were visually assessed at 5, 12, and 19 days after application.

The additives used in the trial had a limited impact on herbicide efficacy or weed control in soybeans. Five days post-treatment, leaf burn was lower with the Roundup + Liberty + Enlist combination than the Reflex + Basagran + Select Max combination. The addition of Microplex increased injury in the Roundup-based treatment from 2% to 8%. Injury from the Reflex-based treatment increased with the addition of ENC Flex and sucrose. Stunting at five days after treatment followed the same pattern as leaf burn. Fertilizer additives had no noticeable impact at 12 or 19 days after treatment.

Palmer amaranth control was better with Roundup-based treatments than with Reflex-based treatments. Only one significant difference was observed with adding nutrient additives: Microplex reduced Palmer amaranth control by 10% when tank-mixed with the Reflex-based treatment.

Overall, nutrient additives had a limited impact on crop safety or herbicide performance. When nutrient additives were included, no season-long differences in herbicide performance were observed. However, this study used only three products, so we need to be careful about generalizing across all nutrient additives.

Assessment of Non-Targeted Site Herbicide Resistance in Palmer Amaranth at Growers Field in Delaware

NAVEEN KUMAR (UNIVERSITY OF MARYLAND EASTERN SHORE)

This project was extended into 2025.

Evaluating Common Preemergence Herbicides for Relative Crop Safety

MARK VANGESSEL (UNIVERSITY OF DELAWARE)

Table 2: Herbicide single and combination treatments.

TrtNo.	Herbicide 1		Herbicide 2		Valor EZ
1	Dual Magnum				22oz/ac
2	Dual Magnum	+	Metribuzin		140k seeds/a
3	Spartan				32oz/a
4	Spartan	+	Metribuzin		1qt/a
5	Valor EZ				1qt/a
6	Valor EZ	+	Metribuzin		
7	Classic	+	Metribuzin		
8	Spartan	+	Classic		
9	Spartan	+	Classic	+	Metribuzin
10	Valor EZ	+	Classic		
11	Valor EZ	+	Classic		
12	Untreated Check			+	Metribuzin

Overview of preemergence herbicide treatments tested in the soybean crop safety trial. Each treatment included single or combination applications of common herbicides to evaluate crop injury and yield response under early and conventional planting dates.

This project examined the crop safety of common preemergence herbicides in soybeans, focusing specifically on the potential for crop injury rather than weed control. With limited regional data available—especially as new herbicide premixes are introduced—this study aimed to help Delaware soybean growers make more informed decisions, particularly as many shift to earlier planting dates. Researchers tested five herbicides—Dual Magnum, Metribuzin, Valor EZ, Spartan, and Classic—alone and in combinations at rates 25% higher than label recommendations. Treatments were applied to two soybean varieties (AG37XF1 and AG38XF3) planted on April 15 and May 13, representing early and conventional planting dates. The trial was conducted in no-till conditions, with plots sprayed one day after planting and evaluated regularly to assess herbicide-induced crop injury over time.

Results showed that visible crop injury was generally higher in May-planted soybeans than in April-planted ones, though area-under-the-curve (AUC) values indicated less sustained injury over time for the May plantings. Classic (chlorimuron) consistently caused the most stunting, especially in combinations with other herbicides, though this did not always translate to yield loss. In fact, Classic-containing treatments reduced yields only in May-planted soybeans, particularly when combined with metribuzin. April-planted soybeans yielded more overall, but three treatments—Dual alone, Dual + metribuzin, and Valor + metribuzin—caused yield reductions despite minimal visible injury.

While AG38XF3 showed slightly more injury than AG37XF1, variety differences were not statistically significant. Interestingly, metribuzin—often a concern among farmers—was relatively safe and had inconsistent effects when mixed with other herbicides.

The study concluded that visible crop injury does not always lead to reduced yields, especially for early-planted soybeans. However, caution is advised when using chlorimuron products, particularly to avoid overapplication or overlapping. Growers should also be careful when using Dual and metribuzin in early planting scenarios, as these showed yield reductions despite low visible injury. Valor EZ proved to be a safer herbicide option with less crop injury compared to Spartan. Overall, the findings highlight the need for further research focused on early planting dates to better understand herbicide interactions and improve soybean production practices in the Mid-Atlantic region.

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