OHIO SOYBEAN COUNCIL

RESEARCH 21

WINNING SOLUTIONS TO ON-FARM CHALLENGES

Ohio soybean farmers and scientists at The Ohio State University (OSU) make a winning team. With research funded by the Ohio Soybean Council (OSC) and soybean checkoff, scientists can find new and innovative solutions to help farmers succeed in their field. This report highlights the latest soybean research funded through your soybean checkoff. Inside, you will find winning solutions to some of the biggest challenges facing Ohio farmers.

With a goal to drive innovation, OSC invests in projects that discover how to increase yield, reduce costs and protect the land. We partner closely with OSU's Center for Soybean Research, as well as regional and national organizations like the North Central Soybean Research Program (NCSRP), United Soybean Board (USB) and the Soybean Cyst Nematode (SCN) Coalition. This collaboration allows us to maximize checkoff dollars without duplicating important soybean studies.

To discover all the ways your soybean checkoff dollars fund plant research programs that support Ohio farmers, visit ohiofieldleader.com.

Todd Hesterman

Research Committee Chair, Ohio Soybean Council

Todd Hesterman farms nearly 1,000 acres of soybeans, corn and wheat in Henry County. He previously served as the Ohio Soybean Association's President, First Vice President and Treasurer. He earned a B.S. from The Ohio State University in Agronomy and holds a Certified Crop Advisor designation.

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OFFENSE

IN-DEPTH INVESTIGATION OF SOYBEAN SEEDING RATE

DR. LAURA LINDSEY,

Associate Professor, The Ohio State University, State Soybean and Small Grains Specialist

QUESTION/CONCERN:

What is the optimum seeding rate to plant for early-, middle- and late-planted soybeans?

PROBLEM:

Many farmers are very interested in reducing soybean seeding rates as the cost of soybean seed is a significant portion of their budget. Identifying the agronomic optimum and economic optimum seeding rate based on early-, middle- and late-season planting dates is an important factor in making seeding rate decisions.

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SOLUTION:

Study multiple seeding rates, across two locations, at four planting dates.

RESULTS:

- Planting date and seeding rate interactions were location and growing environment specific.
- Soybeans are very sensitive to drought stress between R3-R5 (pod set to grain fill).
- In Central Ohio, there was a 1/2 bushel yield loss per day for each day planting was delayed after May 1st.
- In Northwest Ohio, the middle-to-late planting date beans yielded better due to drought stress during the R3-R5 growth stages for the earlier planted soybeans.
- For May planting dates (early), final stand counts should be 100,000-120,000 plants per acre.
- For June planting dates (late), final stand counts should be 130,000-150,000 plants per acre.

ADDITIONAL INVESTIGATION WITH THIS PROJECT:

Determine the cause of self-thinning and examine the effects of seeding rate and nematicide seed treatment on both yield and soybean cyst nematode (SCN) populations.

ADDITIONAL FINDINGS:

- Soybeans planted at higher seeding rates showed a greater reduction from the initial stand to the final stand. This is most likely due to the soybeans thinning at the higher populations. A 100,000 plants-per-acre final plant stand at harvest is optimum.
- SCN is not impacted by the seeding rate.
- Soybean root biomass did not change based on the seeding rate.
- Soybean above-ground biomass is the same regardless of seeding rate due to the bean's ability to compensate at lower populations with greater spacing.
- A nematicide seed treatment alone is not sufficient to protect against SCN. The use of resistant cultivars and crop rotation is also needed.

> **The later you plant soybeans, the narrower the rows should be (7.5" or 15" versus 30" row spacing) in order to canopy sooner which helps keep the soils cooler and retain moisture and also capture more sunlight.**
>
> **Dr. Laura Lindsey**
> Associate Professor, The Ohio State University, State Soybean and Small Grains Specialist

OFFENSE

UNMANNED AERIAL VEHICLES (UAVS) FOR MONITORING SOYBEAN DEFOLIATION BY PESTS

DR. SAMI KHANAL,

Assistant Professor, Department of Food, Agricultural and Biological Engineering, The Ohio State University

QUESTION/CONCERN:

How can farmers more efficiently scout for soybean leaf defoliation from pests?

PROBLEM:

Soybean leaf defoliation from insect feeding reduces soybean yield. Having timely defoliation information to make important pest management decisions is critical when protecting plant health and yield potential. It is challenging to accurately assess soybean defoliation from pests throughout the growing season by on-ground scouting. Efficiently scouting soybean fields during the later parts of the growing season, as plants grow larger, takes longer and is physically more difficult. UAV-based remote sensing technology could be used to quickly assess insect feeding damage in the field to aid with management decisions. This would contribute greatly to efficient data collection. Currently, the ability of available technology to collect and interpret such data is limited. It is unknown how accurate visual and multispectral sensors will be in this process, and at what altitude they must operate to be effective.

SOLUTION:

Collect data using UAV-based remote sensing technology along with on-ground scouting to verify and correlate the data collected. Determine the appropriate altitude for UAV and sensor operation to adequately collect the needed imagery. Develop a model to correlate imagery with defoliation rates. Develop a model to correlate upper canopy defoliation and whole field comprehensive data with defoliation severity. Analyze multispectral data collected to determine correlations with visible imagery and on-ground scouting data.

RESULTS:

It was determined that a height of 10 meters was necessary for the UAV to operate and not have an adverse impact on the imagery due to leaves turning from the turbulence, which could negatively impact the collection of imagery data.

- An image processing tool is being utilized to analyze collected UAV imagery and determine leaf surface area and defoliation levels.
- A ratio is being developed to calculate the soybean defoliation rate based on the UAV-collected imagery data in relation to on-ground scouting data.
- A model is being developed to correlate the defoliation levels from the imagery data with the on-ground scouting data.
- A learning algorithm is being created to allow machine learning in a variety of environments and growing conditions at numerous defoliation levels.
- Data collected from multispectral sensors is being processed and analyzed to determine the ability of multispectral data in this application compared to visible data, and in the future compared to thermal imaging data.

We are working on a framework focused on developing a deep learning algorithm for quantifying soybean defoliation using visible imagery.

Dr. Sami Khanal

Assistant Professor, Department of Food, Agricultural and Biological Engineering, The Ohio State University

OFFENSE

COVER CROP BENEFITS AND THE SOYBEAN MICROBIOME

DR. SOLEDAD BENITEZ-PONCE,

Assistant Professor, Phytobacteriology, The Ohio State University

QUESTION/CONCERN:

Many farmers do not have a good understanding of the impact of winter cover crops in a corn-soybean rotation on the soil microbes and the resulting benefits to soybean health and yield.

PROBLEM:

It is not known which groups of microorganisms correlate with soybean yield benefits within a corn-soybean rotation that includes a cereal rye and radish cover crop.

SOLUTION:

Identify groups of microorganisms which consistently and positively correlate with soybean yield benefits within a corn-soybean rotation that includes a cereal rye and radish cover crop (corn-cereal rye-soybean-radish). In the first year, evaluate the dynamics of the microbial community in response to a cereal rye cover crop and the interaction with the subsequent soybean crop.

> **The biggest shift we see in the bacterial and fungal community is before and after the rye cover crop is terminated with glyphosate.**
>
> **Dr. Soledad Benitez-Ponce**
>
> Assistant Professor, Phytobacteriology, The Ohio State University

RESULTS:

Research is ongoing and will focus on how cover crop termination timing affects soil microbes.

- The soil microbiome (fungal and bacterial communities) change over time.
- The microbiome communities were stable when the corn crop was harvested and again stable when going into the period when rye was planted.
- Measurements were taken when the rye was growing and before and after it was terminated with glyphosate. A big shift was observed when the rye was killed with the glyphosate.
- By the time the soybeans were planted that same difference in the microbiome community (from when it was harvested corn going into rye) was not observed.
- We can track the dynamics of this community and how they are changing over time.
- Identification of the fungi is specific and the DNA of the fungi in the soil is analyzed.
- We can identify which fungi are present at each time-point in the soil. We get an idea of which are most abundant, and which are least abundant of the different species of fungi present at different times in the microbiome.

OFFENSE

A HIGHLY EMBRYOGENIC THORNE SOYBEAN LINE

DR. JOHN FINER,

Professor, Department of Horticulture and Crop Science,
The Ohio State University, Soybean Biotechnology

QUESTION/CONCERN:

A rapidly growing embryogenic soybean line is needed for improving transformation and genome editing efficiencies.

PROBLEM:

Until now, the process of genome editing in soybeans has been consistent but inefficient. A rapidly growing line is needed that shows potential for improving transformation and genome editing efficiencies. Embryogenic cultures provide a suitable target tissue to produce transgenic and genome-edited soybeans.

SOLUTION:

A unique and potentially valuable highly embryogenic Thorne soybean line has been isolated. There is a need to characterize Thorne by evaluating the growth under different conditions and then subjecting it to transformation and genome editing approaches to generate products of use to OSU collaborators. This research will reduce or eliminate the current bottleneck for producing modified soybean lines.

RESULTS:

A new variant of the Thorne soybean line has been isolated. A unique approach has been developed for genome editing. This line grows 3-5 times more rapidly than other lines and shows tremendous potential for improving transformation and genome editing efficiencies.

> **Every time we generate these new lines, we learn a little bit more about how to do it.**
>
> **Dr. John Finer**
>
> Professor, Department of Horticulture and Crop Science, The Ohio State University, Soybean Biotechnology

OFFENSE

BREEDING AND DEVELOPMENT OF A BREADTH OF SOYBEAN CULTIVARS

DR. LEAH MCHALE,

Associate Professor, Department of Horticulture and Crop Science, The Ohio State University, Plant Breeding and Genetics

QUESTION/CONCERN:

Ohio soybean growers have specific needs in soybean cultivar development. This includes disease resistance and specialty traits. Soybean breeding and research efforts are needed to develop soybean varieties for specific markets with key traits including resistance to Ohio-important diseases, composition traits and niche food grade market traits.

PROBLEM:

To integrate *Phytophthora sojae* resistance with soybean cyst nematode (SCN) resistance is very complex. Breeding quantitative resistance into soybeans for P. sojae and SCN is challenging because it is controlled by several different genes that each contribute to the trait. Research has identified one specific gene that contributes a large amount to the trait of quantitative resistance, and the presence of this one gene has been shown to significantly impact yield in diseased fields. It is rare for one quantitative trait to show this type of significant resistance impact in the field. The problem is that the desired gene is genetically located very close to an important SCN gene. The resistance gene for P. sojae is associated with susceptibility to SCN, and the opposite is true as well. Research is needed to determine how close the genes are to one another and gather enough recombinant material to find a genetic mix that has broken the link between the two, which will exhibit resistance to both.

Food grade soybean research is unique in that the food grade varieties are very specific. Food grade soybean research can be dependent on where the seeds are grown. Industry partners assist by telling researchers what food grade lines should be advanced for the food grade market.

SOLUTION:

Conduct research to determine how close the P. sojae and SCN resistance genes are to each other. Conduct further research to find how to break the link between the genes that create P. sojae and SCN resistance.

In the final year of field testing, interested industry partners will test the new variety before it is released. General testing is done for protein, oil, yield, etc. Final stage testing includes the tofu yield and firmness. Research direction and seed advancement input is provided by industry partners.

RESULTS:

Dr. McHale is collecting and developing recombinant material that potentially has the genetic make-up that has broken the linkage and possesses resistance to both P. sojae and SCN.

OSU researchers will continue to work with industry partners to bring new food grade varieties to market.

> **Resistance that integrates P. sojae and SCN is a challenge because the desired gene is genetically located very close to an important SCN gene.**
>
> **Dr. Leah McHale**
>
> Associate Professor, Department of Horticulture and Crop Science, The Ohio State University, Plant Breeding and Genetics

DEFENSE

MANAGEMENT OF SOYBEAN INSECT PESTS

DR. KELLEY TILMON,

Associate Professor, Entomology Field Specialist, The Ohio State University

QUESTION/CONCERN:

- What are the most concerning soybean insect threats?

PROBLEM:

- Stink bugs are the biggest insect threat for Ohio soybeans currently. Stink bug insecticide resistance is an increasing problem in the southern United States and could possibly become one in Ohio.
- Ohio needs to have a method to monitor stink bug field populations and determine stink bug insecticide resistance levels.
- Soybean aphids may have developed a new biotype capable of overcoming the new triple-stack anti-aphid soybean varieties.
- New soybean pests like soybean gall midge are being identified in soybean growing regions.

SOLUTION:

- Alert growers about the distribution and variety of stink bug species.
- Develop a test to evaluate stink bug insecticide resistance levels.
- Determine how pheromone-baited sticky cards can be used as a monitoring tool and make stink bug scouting easier and more efficient.
- Determine whether a new soybean aphid biotype can overcome the new triple-stack anti-aphid soybean varieties.

> **Stink bugs are emerging as Ohio's biggest soybean insect pest. The brown marmorated stink bug is a non-native stink bug that was first found in eastern Pennsylvania and is spreading west into Ohio.**
>
> — **Dr. Kelley Tilmon**
> Associate Professor, Entomology Field Specialist, The Ohio State University

RESULTS:

Data was collected during the 2020 growing season from eight fields across four research farms. Stink bug populations are being calculated along with the level of soybean seed feeding damage in an effort to correlate the two.

Tests were conducted to determine potential stink bug insecticide resistance. A stink bug colony was tested against lambda-cyhalothrin (Warrior) at the labeled rate. All stink bugs were killed indicating no resistance. A leaf drip test was also conducted to check for insecticide retention. Twenty-four hours later stink bugs were introduced to the drip test plants and all the stink bugs died.

Sticky trap cards were used at six sites on The Ohio State University Wooster Campus farms in 2020. Stink bug numbers are being tallied and data is being compared with companion collaborative research from the University of Missouri.

Aphid colonies have been screened and one aphid colony from Illinois appears to have survived on a triple-stack three-gene seed.

Identification and scouting cards have been created and are being printed for distribution to Ohio soybean farmers and industry partners. Electronic versions have also been developed and are available on https://aginsects.osu.edu/

DEFENSE

MANAGEMENT OF AMARANTH POPULATIONS IN OHIO SOYBEANS

DR. MARK LOUX,

Professor, Department of Horticulture and Crop Science, The Ohio State University, State Weed Specialist

QUESTION/CONCERN:

How can Ohio farmers better control weeds?

PROBLEM:

Palmer amaranth and waterhemp are two weeds that are prolific seed producers. These are still relatively unfamiliar weeds to most farmers. If scouting is not being done, by the time farmers realize their fields have a population, the weeds have increased to problematic levels. The weeds are developing multiple-sites-of-action herbicide resistance. They are also producing seed.

SOLUTION:

Collect and screen Palmer Amaranth and waterhemp populations for resistance to six different herbicides to gain an understanding of the populations we have in Ohio and what types of resistance are starting to occur.

RESULTS:

We have found that our populations are starting to accumulate characteristics of multiple-sites-of-action herbicide resistance. This is predictable as we are selecting with both pre-emergence and post-emergence herbicides. All the populations screened have two-way resistance, and nearly half of the populations have three-way resistance, including: Group 2 - ALS, Group 9 - glyphosate, and Group 14 - PPO inhibitors. Previous research has indicated that once a three-way resistance is achieved, the populations quickly can jump to a six-way resistance.

> **We know we are moving up the herbicide resistance curve. We are currently collecting and screening our populations against six different herbicides.**
>
> **Dr. Mark Loux**
>
> Professor, Department of Horticulture and Crop Science, The Ohio State University, State Weed Specialist

DEFENSE

IN-SEASON DRAG HOSE DAMAGE ASSESSMENT

> **When the manure is applied to soybeans, it will be taken up, and turned into additional growth, and then held until the plant residue breaks down the following year. The soybean plant is pretty tolerant to the drag hose going over it up through the V5 growth stage.**
>
> **Glen Arnold**
>
> Associate Professor, Agronomy Field Specialist, The Ohio State University

GLEN ARNOLD,

Associate Professor, Agronomy Field Specialist, The Ohio State University

QUESTION/CONCERN:

Can manure be applied to a growing soybean crop without causing harm?

PROBLEM:

With the loss of wheat acres in the state, more farmers are getting away from summer manure application and relying on fall application. The vast majority of liquid livestock manure in the Western Lake Erie watershed is surface applied in the fall without a growing crop. This results in most of the nitrogen being lost, and a portion of the phosphorus. The changing weather patterns and the increased rainfall events, along with fewer available acres, have created a need to find alternatives. With the nature of crop rotations in the Western Lake Erie watershed, the application window to apply manure to growing crops when the nutrients can best be utilized during the growing season is limited. Manure is being applied to newly planted soybean fields prior to soybean emergence. It is assumed that manure cannot be applied to soybeans after emergence due to the risk of damage from equipment tracks and drag hose damage.

SOLUTION:

Conduct trials to explore the potential application of livestock manure to emerged soybeans and determine the soybean plant's ability to tolerate potential physical damage from a drag hose application.

RESULTS:

Trials were conducted at V3, V5, and V7 growth stages. There was no noticeable physical damage to the soybean plants from the drag hose until the V7 growth stage, and even then, it had little negative yield impact. We found manure can be applied to first crop soybeans, or double crop soybeans up to the V5 growth stage.

Manure applied to soybeans is typically not necessary from a nutrient standpoint, but it is an option for farmers to make an in-season manure application if there are storage capacity concerns.

To learn more about this research and other projects funded by your soybean checkoff dollars, visit ohiofieldleader.com

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The Ohio Soybean Council (OSC) was founded in 1991 to manage the Soybean Promotion, Research, and Consumer Information Act, commonly known as soybean checkoff. OSC is governed by a volunteer farmer board, which directs the investments of the checkoff. The program's primary goal is to improve soybean profitability by targeting research and development, education and marketing projects.