2018 RESEARCH REPORT

OHIO SOYBEAN COUNCIL

Nathan Eckel
BOARD OF TRUSTEES
RESEARCH COMMITTEE CHAIR
OHIO SOYBEAN COUNCIL

Growing great soybeans is a group effort. Though we may spend time alone in our combines, we have a team of researchers supporting our work with science. In fact, scientific research backs up everything we do on our farms. From the choices we make about crop inputs to the precision technology we leverage, our best practices are based upon research.

The Ohio Soybean Council (OSC) believes in the power of research to increase yields, reduce costs and protect the land. That's why our organization funds research projects at The Ohio State University (OSU) to investigate the issues that matter most to Ohio farmers. From water quality to insecticide resistance management, OSU researchers are working with Ohio farmers to find solutions to some of the biggest challenges facing the agricultural industry today.

This annual report gives an overview of some of the research projects our checkoff dollars have funded. Inside, you'll learn how these findings can benefit your operation and what studies to keep tabs on. From managing soybean cyst nematodes to reducing nutrient runoff, these projects have the potential to change the way we farm.

OSC works for you. To discover all the ways your soybean checkoff dollars fund plant research programs to support Ohio farmers, visit **ohiofieldleader.com.**

Sincerely,

Nathan Eckel

Nathan Eckel farms nearly 2,000 acres of soybeans, corn and wheat in Wood County on Eckel Grain Farms. He is also the co-owner of Eckel Cattle Company, raising 1,200 head of cattle. Nathan holds a B.S. in agricultural business and applied economics from OSU.

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DISEASE MANAGEMENT: *THE NEW SCN COALITION*

Until recently, the threat from soybean cyst nematodes (SCN) seemed a thing of the past. Thanks to soybean varieties largely derived from the SCN-resistant PI88788 or Peking lines, growers could plant in complete confidence that SCN would not reduce their high yields. Over the past 20 years or so, however, the pathogen has gradually built up its own resistance to these soybean varieties, allowing it to multiply in fields that were previously unaffected.

Anne Dorrance, a plant pathologist at The Ohio State University, understands the gravity of the situation. "This pest is a yield robber. It's not a killer," Dorrance says. She further notes that farmers can't always quickly diagnose the problem because some SCN infestations produce very few visible symptoms. That's why Dorrance is leading Ohio's efforts in the SCN Coalition, a multistate, checkoff-funded collaboration of researchers striving to increase awareness about SCN and develop effective solutions for soybean growers.

The SCN Coalition's slogan is "Take the test. Beat the pest!" meaning farmers should test their soils even if they don't think they have a problem. Over the next year or so, Dorrance will have tested several thousand soil samples from soybean growers all across Ohio. A recently completed study revealed that about 90 percent of tested samples were below the 2,000 eggs/cup soil economic threshold for SCN-related yield loss. However, those samples were taken from high yielding fields. Dorrance feels this may not be giving growers an accurate picture for their whole farm. "I want your lowest yielding spot that you know is not from flooding or something else like that," she says. Dorrance expects this sampling method will show only 75 percent of tested samples are under the economic threshold, especially since she has already documented several SCN hotspots across the state with levels up to 30,000 eggs/cup soil.

Even though resources for combating SCN are limited, Dorrance believes the Coalition will streamline efforts to help farmers now and into the future. In the short term, researchers are evaluating combinations of biological and/or chemical seed treatments with the failing, formerly resistant soybean lines to increase options for farmers. Over the long term, however, researchers are focused on generating new soybean lines with more genetic diversity to allow them to better withstand SCN pressure. With these efforts, combined with farm-specific solutions from Dorrance and other specialists, growers should already see the light at the end of the tunnel for overcoming SCN and enjoying higher soybean yields once again.

Meet the Researcher

ANNE DORRANCE

Degrees & Credentials:

Ph.D. – Virginia Tech, plant pathology

M.S. – University of Massachusetts, plant pathology

B.S. – SUNY College of Environmental Science and Forestry, forest biology

SOYBEAN CYST NEMATODE FACTS:

- SCN has three general life stages: egg, juvenile and adult. In Ohio, the SCN lifecycle takes about three to four weeks, so soybean fields can experience several generations in a single season.
- Cysts are formed when the female nematode dies, leaving a strong protective coating around the egg mass.
- Encased in cysts, SCN eggs can hatch over a long period of time, even years.
- Once hatched, juvenile nematodes feed on the soybean roots.
- This pest is largely spread mechanically by farm equipment or naturally by wind-or water-borne soil.
- The economic threshold for SCN-dependent yield loss is 2,000 eggs per cup of soil.
- Once present in the soil, SCN is rarely eradicated. Crop rotation to non-host plants like corn and wheat can reduce SCN populations, as well as seed treatments and biological controls.
- Over the past 20 years, the pest has slowly adapted to the once very effective SCN resistant soybean varieties. Current research aims to generate new resistant soybeans by including more genetic diversity to greatly reduce the likelihood that SCN populations will survive over the long term.

2 **TANK MIXES AND DOUBLE CROPPING:** *DO THEY INCREASE YIELDS?*

In the quest for high soybean yields, it may be tempting to tank mix an insecticide with a planned fungicide treatment for a single-pass application. After all, insecticide doesn't cost much and mixing with another treatment could save a lot of time and wear and tear on the field.

"Insecticide is like a cheap insurance," says Laura Lindsey, director of the Soybean and Small Grain Crop Agronomy Program at The Ohio State University. "But we don't like blanket application because of resistance issues."

Lindsey, who is often asked by growers about this dual application, has been working on a checkoff-funded project to investigate the potential of this tank-mixed insecticide to increase soybean yields. Her two-year project revealed that fungicide application at the R3 stage in late July did increase yields significantly during the 2015 season. This effect, however, was most likely due to higher disease incidence that year because "2015 was really, really wet," she explains. Addition of an insecticide to the fungicide treatment, however, had no effect on soybean yields. Lindsey also found that her soybean fields were still prone to damage from insects like bean leaf beetles a month or two after application. Without long-lasting insect protection and no observed yield benefit, Lindsey determined that growers can enjoy a small cost savings by eliminating insecticide from their mid-season fungicide regimen.

Despite the negative results on traditionally grown soybeans, Lindsey suspects tank mixed insecticide and fungicide may prove beneficial for double-crop systems. Double-crop soybeans, sometimes referred to as second-season soybeans, are planted immediately after a winter wheat or other small grain harvest in late spring. These soybeans, while planted late compared to traditional methods, still mature in time for the autumn harvest. However, the developmental differences in double-cropped soybeans, compared to the traditionally planted ones, can cause issues for growers. "When you have green plants and everything else around them is dead, this attracts insects," Lindsey notes.

Double cropping is not especially common in Ohio. "Ohio is marginal. Growers south of I-70 usually can do a double crop, but above I-70 is more variable," she explains. It can be a profitable endeavor, and Lindsey wants to help farmers establish conditions needed for high double-crop soybean yields. To do this, Lindsey's checkoff-funded project examines the effects of planting date, soybean relative maturity, row spacing and seeding rate. Planting early is the most important factor for profitability, she determined, because "the later you plant, the higher seeding rates need to be."

In this multiyear study, a seeding rate of 250,000 seeds/acre was necessary to achieve the highest partial economic return. Soybean relative maturity groups with maximal vegetative growing time prior to the reproductive stage are also key for high yields.

Meet the Researcher

LAURA ELIZABETH LINDSEY

Degrees & Credentials:

Ph.D. – Michigan State University, crop and soil sciences

M.S. – The Ohio State University, soil science

B.S. – The Ohio State University, environment and natural resources

CONSIDERATIONS FOR DOUBLE-CROP SOYBEANS:

- Planting date: The earlier the better. Later plantings require higher seeding rates, which diminishes the crop's economic return. Planting early also gives greater assurance the soybeans will be fully developed by harvest time.
- Relative maturity groups: Choose wisely. The optimal RM group will have the longest vegetative stage possible to provide more branches for the flowering stage, while still reaching full maturity prior to the autumn frosts.
- Row spacing: Narrow is best. In Ohio fields, narrow row spacing i.e., 7.5 and 15-inches, resulted in higher yields compared to 30-inch rows commonly used in other states.
- Mode of action: Repeated use of a single chemical or mode of action is discouraged when insect populations are below threshold levels due to risk of insecticide resistance.
- Tank mixing: Treatments of fungicide + insecticide, fungicide + insecticide applied separately, fungicide + crop oil, and fungicide + insecticide + crop oil resulted in yields not statistically different than fungicide treatments alone.

3

INSECT MANAGEMENT: *STINK BUGS AND OTHER SOYBEAN PESTS*

Farmers and urban folk alike have become well acquainted with the brown marmorated stink bug (BMSB). Originally from Asia, this invasive species of stink bug has quickly established itself in the United States as a significant soybean pest. The adult BMSB overwinters in homes and buildings before moving to the lush, green soybean fields in spring and summer.

Unfortunately, BMSB isn't the only stink bug pest Ohio soybean growers must deal with. Eight other stink bug varieties infest soybeans in addition to common pests like grasshoppers and bean leaf beetles. Because there are so many potential insect threats to soybean yields, growers have no choice but to closely monitor their fields to ward off infestations.

Scouting for bugs in a soybean field can be quite a job. Typically, it involves wading through the plants with a large sweep net to brush off the unsuspecting insects. These insects then have to be sorted and counted to determine if a certain threshold has been met to consider the field infested.

Kelley Tilmon, an entomologist at The Ohio State University, always keeps growers in mind for her research projects. Funded by the Ohio Soybean Council, Tilmon is researching whether sticky cards originally developed for orchards will also work reliably in soybean fields to trap insect pests. "We are always looking for ways to make monitoring for insects easier," Tilmon says. For the BMSB, these cards are coated with a specific pheromone lure that attracts stink bugs from the surrounding area. Since the sticky cards are mounted on posts at various locations in the field, the idea is that a farmer can walk by and determine at a glance if the field is infested or not and whether control measures need to be taken. But researchers first need to make sure the sticky cards are giving an accurate representation of the insect population. "We're not sure how far away they will attract the stink bugs and whether they are really indicative of what's in the field, or are they pulling stink bugs in from other areas," Tilmon states.

Additionally, Tilmon and her colleagues have used a similar setup to monitor for kudzu bugs, a pest that typically feeds on kudzu plants in the Southern U.S. but is also quite happy with soybeans. Luckily, the kudzu bug has not invaded Ohio yet, but has already established itself in Kentucky. "These insects are good hitchhikers so that's one of the ways invasive insects can spread, through the nooks and crannies of vehicles," Tilmon explains, noting the reason for continuous monitoring. "It is important for us as researchers to be aware and monitor the situation so farmers don't have to. If we figure it out early, then we can really ramp up our efforts to educate producers about the insect, about the potential damage and what advice we can give for management."

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Meet the Researcher

KELLEY TILMON

Degrees & Credentials:

Ph.D. – Cornell University, entomology

M.S. – University of Delaware, entomology

B.A. – University of Delaware, biology and English

WHY STINK BUGS REDUCE SOYBEAN YIELDS:

- Stink bugs feed on soybean juices, not the tissues themselves. While this may not seem as detrimental as defoliation, it's actually quite devastating to the plant. Since they use a stylet to pierce into the soybean plant, stink bugs prefer to feed on the more tender tissues such as young leaves, flowers and developing seeds. The stink bugs also inject digestive enzymes to help release nutrients at the feeding site, which inflicts further damage.
- Yield loss is, of course, greatest when the stink bugs feed on developing seeds. Since the pods often retain their shape despite having smaller, injured or even aborted seeds from stink bug feeding, growers often don't know the extent of the damage until harvest.

4 WEED MANAGEMENT: *PIGWEEDS IN OHIO*

Just the mention of pigweeds can quickly put dread into farmer and researcher alike. Why? These weeds possess two traits that spell disaster for growers: excessive seed production and rapid herbicide tolerance. Controlling the spread and incidence of these plants is therefore very difficult and requires vigorous management strategies.

Mark Loux, professor of horticulture and crop science at The Ohio State University, is leading an OSC-funded campaign to increase awareness among Ohio farmers about two particular pigweeds: Palmer amaranth and waterhemp. “Our four big weeds in the Midwest are giant ragweed, marestail and those two pigweeds,” Loux says.

Loux realizes that communication and education are key to helping farmers prevent these aggressive weeds from taking over their fields. Together with extension educators, Loux distributes posters, videos and thousands of packets every year with information on how to identify and prevent the spread of Palmer amaranth and waterhemp weeds.

“Once we have it come into a field or an area, what we try to do is a community effort, where it’s identified and we get everybody together and tell them ‘You don’t want this weed in the area,’” he says. Sometimes a grower may allow a few lone plants to set seed, thinking they can be taken care of the following year. “If you take that approach with waterhemp once, you’re sort of about halfway into a massive problem. And then you do it again and you’re just sort of game over. You just have this massive mess,” Loux says.

Control efforts can be very difficult, though. “Palmer has to be treated when it’s very small post-emergence, even smaller than waterhemp,” Loux says. In addition to this small window for herbicide treatment, pigweeds are notorious in their ability to become immune. “They tend to develop resistance to whatever is used on them after about three to four times,” Loux says. To address this, he and his collaborators are helping growers across Ohio determine how resistant their pigweeds are to different types of herbicides to save them time and money the following season. “The problem with beans is we’ve used up more of our post-emergence options than we have in corn, so it’s just more difficult,” he says.

Prevention, Loux notes, is still the best strategy to managing these pigweed problems, even if it means walking the fields and pulling the weeds out by hand. “Usually the first time someone sees a new weed is going to be late season when it escapes their program. So you need to do some extra scouting with binoculars or whatever to check the field in August to see what’s out there.” Taking this advice, in addition to implementing targeted herbicide treatments based on resistance testing of previous season weeds, will greatly reduce the risk of new pigweed infestations across Ohio.

Meet the Researcher

MARK LOUX

Degrees & Credentials:

Ph.D. – University of Illinois

M.S. – University of Illinois

B.S. – University of Delaware

KEY POINTS:

- Spray pigweeds while they're small. Herbicides work best when applied to Palmer plants less than three inches tall.
- Make every effort to remove pigweeds before they set seed, as they can produce several hundred thousand seeds per plant.
- Be on the lookout for pigweeds later in the season. Herbicide-resistant plants will still be growing, so scan your soybean fields with binoculars to spot the lingering weeds.
- Testing this season's pigweeds for types of herbicide resistance will help with planning effective control treatments for next year.

5 NUTRIENT MANAGEMENT

Nutrient management is an important aspect of soybean farming, because knowing when and how much of a fertilizer to apply is key to high yields. Growers strive to maintain healthy fields and at the same time reduce runoff to both minimize costs and adverse effects to the environment. This is especially the case for those in the Lake Erie region, where farmers have increased their nutrient best management efforts to curb algal blooms.

What's lacking a reliable method to assess these management practices state-wide.

To address this issue, John Fulton, a professor within the department of Food, Agricultural and Biological Engineering at The Ohio State University, has recently completed an OSC-funded pilot study to develop a database of information that showcases the success of Ohio farmers in their efforts to maintain water quality in the Lake Erie watershed and across the state. "The intent is to develop an annual report for Ohio agriculture - crops and livestock - that outlines voluntary adoption of BMPs (best management practices) that enhance nutrient management," Fulton says.

Currently, the closest method Ohio has for an annual reporting system is the voluntary 4R certification program that nutrient retailers and service providers participate in. Fulton's project similarly evaluated information from consultants and retailers, but also sought to gather even more specific data directly from Ohio farmers. This aspect of the project is unusual, even among nutrient management programs in other states. "Our ability to collect field-level information is somewhat unique as other states aren't quite going to that resolution yet," Fulton says.

The main purpose of Fulton's study was to determine if field-level data could be accessed. Initially, some growers were concerned about confidentiality as well as the time and monetary costs of participation. "I think once you outline what it could do, it's definitely a positive response," Fulton explains. In addition to individual farmers, Fulton interviewed retailers and consultants to gather information on BMPs utilized across the state. Thanks to all the participants, the pilot project yielded useful information. "We were really able to line out what the potential is and what we could report out," Fulton says.

With the pilot study complete, Fulton is now working with commodity groups to develop a state-wide voluntary reporting method. "There's an interest to attempt to build a program that would help do this. The question is to be able to scale it to a level that represents what's happening not only in the Lake Erie watershed, but in the future across Ohio. I think we've gotten insights to that, we understand there's potentially some ways that could be done. And those are the discussions that are really just starting to begin. What are those next steps and how do we move forward and make something like this happen," Fulton says.

Once fully implemented, the reporting program will give environmental policy makers an accurate representation of Ohio growers' nutrient management success.

Meet the Researcher

JOHN FULTON

Degrees & Credentials:

Ph.D. – University of Kentucky, biosystems & agricultural engineering

M.S. – University of Kentucky, agricultural engineering

B.S. – Wittenberg University, physics

IN A NUTSHELL:

- Nutrient best management practices are being implemented by farmers all across Ohio, but methods to evaluate their overall success still need to be developed.
- This pilot study gathered specific, field-level data from growers and retailers in a secure and confidential manner. This information was then aggregated to create a state-wide summary of nutrient BMPs.
- Now that the researchers have confirmed that such data can be reliably collected, they are now exploring options for developing a reporting program that facilitates more comprehensive analysis on an annual basis.
- With an annual reporting method in place, policy makers will be better informed on the commitment Ohio's agricultural community has for nutrient management.

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DEVELOPING RESISTANT CULTIVARS: *VIRUS INDUCED GENE SILENCING IN SOYBEANS*

Developing new soybean cultivars resistant to disease and pests is not an easy endeavor. It often entails years of careful work to tease out the function of genes in the soybean plant, of which there are over 60,000. By crossing susceptible soybeans to resistant ones and then testing the resulting progeny, researchers can slowly determine which parts of the genome are important for resistance. At this stage, scientists are often faced with a long list of candidate genes that need to be analyzed one by one to verify their functions.

A conventional method for determining gene function in plants is to simply delete the gene from the genome. This is more easily said than done, as the process can take months to even years to complete because the first attempt often needs to be repeated. Since this timeframe is not practical when so many genes need testing, researchers have turned to a relatively rapid technique involving viruses for short-term gene inactivation. While the results can't be passed on to the next generation of soybeans like the traditional deletion method can, the Virus-Induced Gene Silencing system (VIGS) can be used to quickly prove or disprove a soybean gene's importance for resistance.

Feng Qu, a virologist at The Ohio State University, is the go-to person for soybean researchers who want to utilize VIGS once they have a list of candidate genes that might be responsible for resistance. "Our research is not just to silence the gene. Specifically, we don't just see if the plant looks different. We also want to see if the plant becomes more or less susceptible to pathogens like Phytophthora sojae or aphids," Qu says.

Sometimes, the process is successful at silencing the target genes, but there's no change in soybean resistance, indicating the gene has an unrelated function. The process of developing the modified virus, infecting the plant and confirming gene silencing can take two and a half to three months. "A lot of times, we know the gene we want to silence is silenced, but we don't see any change in susceptibility," Qu states. "That's the most common problem."

But persistence pays off. Qu recently collaborated with entomologist Andy Michel on a checkoff-funded project to find resistance genes against soybean aphids. Using the DNA sequences from the seven candidate genes Michel identified, Dr. Qu made each into unique virus vectors to infect an aphid-resistant soybean cultivar.

The next step was to test how the plants responded to aphids.

"It was a lot of work," Dr. Qu explains, detailing how they had to synchronize aphids to be the same age before applying them to the gene-silenced plants. Out of the seven genes they silenced, one paid off. "The plants that were originally resistant to aphids became more susceptible so we know we hit the right gene," Qu says. Now, Qu has to confirm this result using the more stable method of deleting the gene from the soybean's DNA. If the genetically modified plants show the same increase in susceptibility to aphids, the identified gene can be placed on the high priority list for developing new aphid-resistant soybeans.

Meet the Researcher

FENG QU

Degrees & Credentials:

Ph.D. – Institute of Microbiology, Chinese Academy of Sciences

M.S. – Institute of Epidemiology and Microbiology, Chinese Academy of Preventative Medicine

B.S. – Nantong Medical College, China

HOW VIGS WORKS:

- Several plant viruses, such as bean pod mottle virus or apple latent spherical virus, can be used for virus-induced gene silencing.
- Researchers modify the viruses by adding the plant gene of interest.
- When plants are infected with the modified virus, the plant starts targeting the virus genome to disable it. Since this virus also contains soybean gene sequence, the plant ends up inactivating all copies of that gene including the ones in its own cells.
- Ultimately, the soybean's defense system against viruses does an effective job at silencing specific plant genes, making research on gene function substantially more time efficient.
- Once genes are silenced, the researcher can monitor the soybean's response to a disease or pest. If the soybean becomes more susceptible, then the silenced gene is needed for resistance. Conversely, if the plant has increased resistance once the gene is silenced, then researchers know to avoid integrating that gene into new cultivars.

IDENTIFY Soybean Candidate Genes

MODIFY Plant Virus

INFECT Soybeans with Modified Virus

TEST Soybean's Response to a Disease or Pest

INTEGRATE Data Into Soybean Breeding Programs

To learn more about how the Ohio Soybean Council and its plant research programs support Ohio farmers, please visit our website: **ohiofieldleader.com**

OHIO SOYBEAN
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The Ohio Soybean Council (OSC) was founded in 1991 to manage the Soybean Promotion and Research Program, more commonly known as the 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 promotion projects.