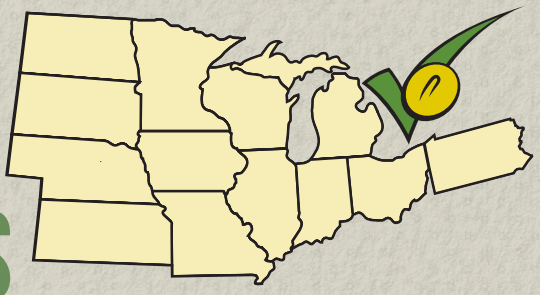
NORTH CENTRAL SOYBEAN RESEARCH PROGRAM
2020 RESEARCH REPORT

NCSRP BUILDS PRODUCTIVE PARTNERSHIPS

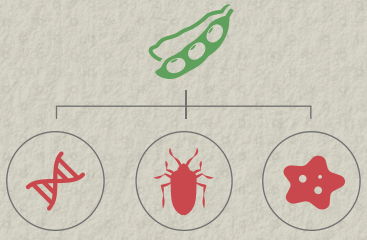


THAT WILL

ACCELERATE AND EXPAND

THE IMPACT OF

SOYBEAN FARMER CHECKOFF INVESTMENTS



2020 NCSRP RESEARCH PROJECT SUMMARIES CAN BE FOUND ONLINE AT:

NCSRP.com and SoybeanResearchInfo.com

PROJECTS FUNDED IN FY2020:

- Discovering and finally understanding the functions of genes that underlie major agricultural traits in soybean
- Boots on the ground: Validation of benchmarking process through an integrated on-farm partnership
- Multi-pronged strategies to provide efficient, sustainable, and durable control to Sclerotinia stem rot
- An integrated approach to enhance durability of SCN resistance for long-term strategic SCN management (Phase II)
- Developing an integrated management and communication plan for soybean sudden death syndrome
- Soybean gall midge: Surveying the North Central region, adult monitoring and host plant resistance
- Expanding the SCN Coalition
- Non-transgenic generation of herbicide resistance in soybean using CRISPR base editing
- Manipulating a major gene governing seed reserves as a means to maintain yield and oil while increasing protein
- Soybean entomology research and Extension in the North Central Region
- Increasing soybean genetic gain for yield by developing tools, know-how and community among public breeders in the North Central US region

NCSRP DELIVERS SHORT- AND LONG-TERM

BENEFITS TO FARMERS

AND PROVIDE THE

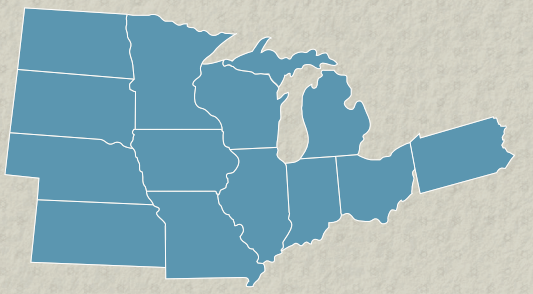
SOYBEAN INDUSTRY

WITH IMPORTANT TECHNOLOGICAL

ADVANCEMENTS AND INFORMATION

AND THE NEXT GENERATION OF SOYBEAN RESEARCHERS

2020 NCSRP BOARD OF DIRECTORS



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13 MEMBER STATES REPRESENT MORE THAN **355,000** SOYBEAN FARMERS

AND MORE THAN

85% OF THE SOYBEANS PRODUCED IN THE U.S.

WHO WE ARE

The North Central Soybean Research Program (NCSRP) is recognized as a leader in multi-state collaborative research and outreach efforts to support soybean farmers and drive the soybean industry forward. The focus of NCSRP is soybean production research and extension outreach. NCSRP's emphasis on enhancing and protecting soybean yield through genetics and agronomic practices contributes to soybean farmer success today and tomorrow.

Mission:

NCSRP will serve as a bridge between state and national soybean organizations and will be the recognized leader in funding and communicating basic and applied soybean research programs that are highly collaborative and uniquely appropriate in addressing soybean production, profitability and environmental sustainability for growers across the North Central region.

Guiding Statements:

1. NCSRP Executive Board will review overall program impact and success and establish specific research priorities of regional importance on a five-year cycle (e.g. key diseases, insects, production practices, etc.).

2. NSCRP funded programs and projects will not be redundant with current state (QSSB) or nationally (USB) funded programs but may complement and extend state or nationally funded projects when addressing the common interests and needs of North Central region soybean growers.

- NCSRP will maintain communication and collaborative connectivity with QSSBs and the USB to maintain awareness of state and national soybean research priorities and funding.
- Regional researchers submitting proposals for NCSRP funding must provide clear statements of research being funded by a QSSB or the USB.

3. Multi-year research project or program proposals will be accepted for funding consideration, but annual renewal will be predicated on successful generation and communication of meaningful annual results.

4. NCSRP emphasizes the collection, compilation and dissemination of research results through appropriate peer reviewed scientific abstracts and journals, extension publications, farmer-focused bulletins, appropriate websites (Soybean Research & Information Network) and databases (National Soybean Checkoff Research Database).

Collaborative Soybean Research Objectives and Priorities:

1. Soybean yield and quality enhancement through genetic improvement and biotic and abiotic stress mitigation for soybean maturity groups 0-IV.

- Classical and molecular soybean breeding efforts that will enhance yield potential and yield stability clearly focused to the North Central region.
- Research that addresses the control of insects and diseases (defensive traits) with consistent or potentially significant economic impacts across the North Central region.
- Research that addresses weed resistance to herbicides for species of common occurrence and threat across the North Central region.
- Research that addresses soybean response to water, nutrients, soil and environmental conditions unique to the North Central region.

2. Soybean production practices that will increase yield, profitability and environmental stewardship issues specific to the North Central region.

- Soybean–corn rotations
- Plant populations, row spacing and input management
- Water quality and watershed planning
- Cover crops and other conservation agronomy
- Soybean production sustainability and life cycle assessment and life cycle assessment.

INDIANA SOYBEAN ALLIANCE · MICHIGAN SOYBEAN COMMITTEE · KANSAS SOYBEAN COMMISSION · WISCONSIN SOYBEAN ASSOCIATION · North Dakota Soybean Council Our World Is Growing · NEBRASKA SOYBEAN BOARD · OHIO SOYBEAN COUNCIL · PSB PENNSYLVANIA SOYBEAN BOARD Progress Powered by U.S. Farmers · SOUTH DAKOTA SOYBEAN CHECKOFF · MISSOURI SOYBEANS · MINNESOTA SOYBEAN RESEARCH & PROMOTION COUNCIL · IOWA SOYBEAN Association · ILLINOIS SOYBEAN ASSOCIATION CHECKOFF & MEMBERSHIP PROGRAMS

LETTER FROM THE PRESIDENT

Ed Cagney, Scotts, Michigan

As we all know, 2020 was a year unparalleled to any other. Weather events including the August Derecho severely damaged many producers' livelihoods across the North Central region, only to be over-shadowed by the COVID-19 pandemic, touching us all personally and professionally. Even though our jobs of planting and harvesting lent themselves more easily to social distancing – the agriculture industry did not come through 2020 unaffected.

Those of us working for the North Central Soybean Research Program (NCSRP) pushed through these challenges and advanced work to improve soybean quality and productivity for farmers today and in the future. The board last met in person at Commodity Classic in February 2020, shortly before pandemic precautions were put in place. Since then, we have met virtually and awarded FY21 funding for 10 research projects.

The 11 research projects funded in FY20 are being finalized and represent a cross-section of topics that illustrate how NCSRP keeps soybean farmers and their profitability top-of-mind. Several projects explored the mitigation of the soybean cyst nematode (SCN) genetically and through on-farm management; several projects dealt with genetic gain for improved soybean protein, oil, and pest resistance; and others looked at better control of diseases including sudden death syndrome and Sclerotinia stem rot.

We hope you read the FY20 project summaries to gain a clearer understanding of how the NCSRP board is investing soybean checkoff dollars to support research in your state and across the North Central region.

Our board will continue to persevere through these new challenges, meeting virtually and, hopefully someday soon, in-person again to strengthen our relationships between scientists and agricultural producers. As I reside only a few miles from a COVID-19 vaccination manufacturing facility, I can see a promising future for us all.

Thank you for trusting me to serve as your NCSRP president.

FROM THE EXECUTIVE DIRECTOR

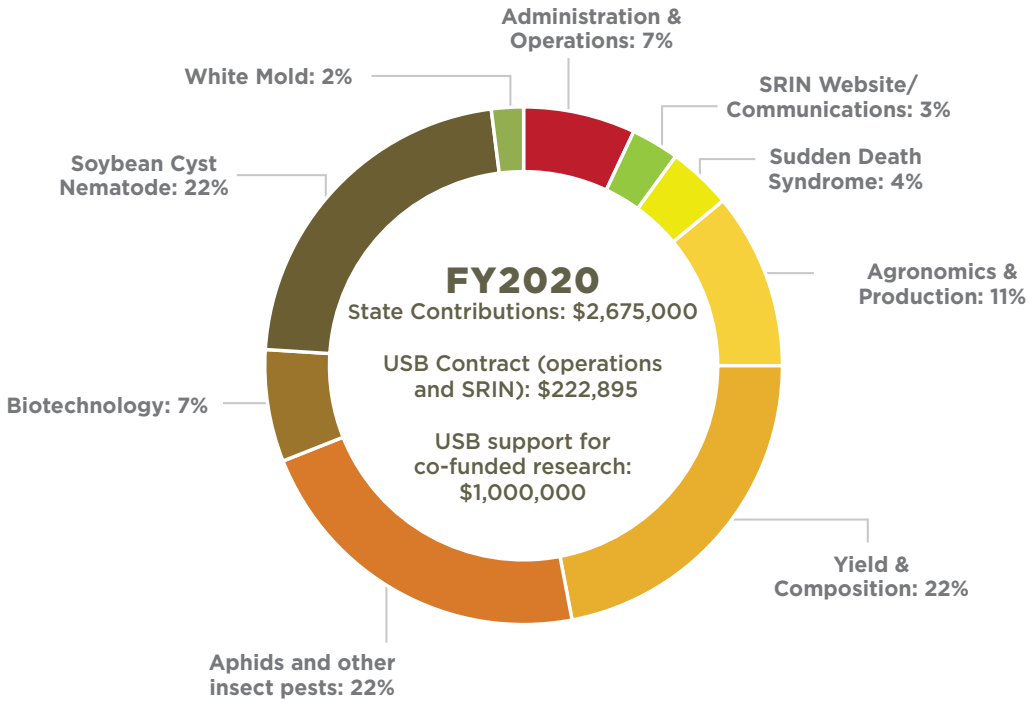
Ed Anderson, Ph.D., NCSRP Executive Director eanderson@iasoybeans.com

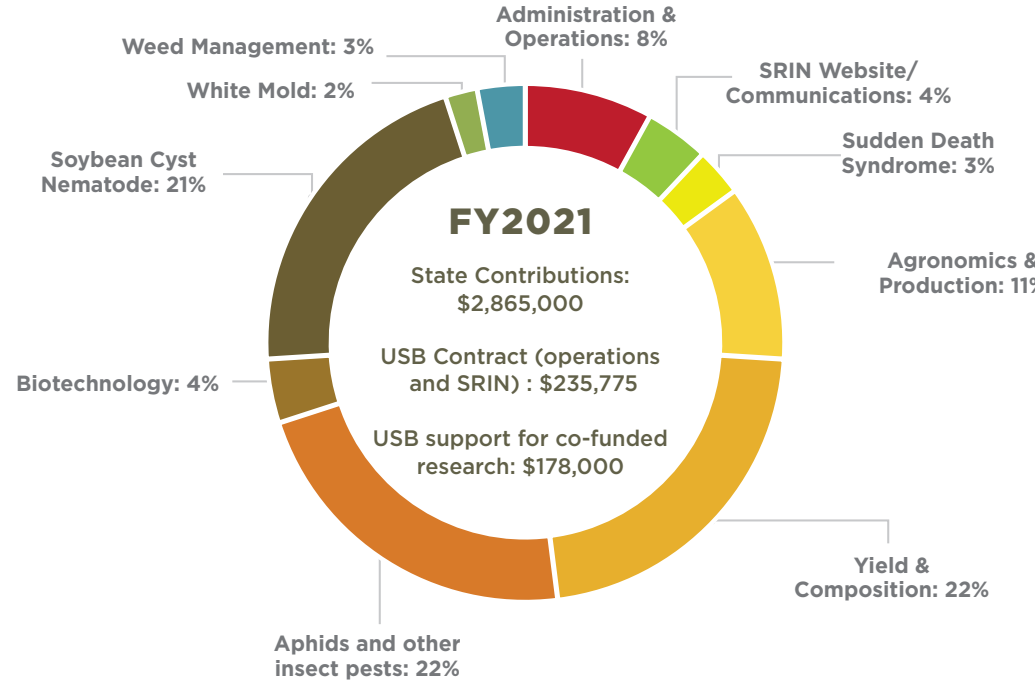
In my letter from FY19, I noted that soybean farmers had faced many challenges, especially due to low soybean prices and other uncertainties in the domestic and international markets. In FY20, soybean farmers and their checkoff organizations continued to face many financial, weather, production and COVID-19 pandemic challenges. But, as always, our soybean farmers and their state staff continue to work hard and maintain focus for the long-term. They are providing a sustained investment in basic and applied soybean production research, teaching and training the next generation of soybean researchers and farmers, and communicating research data and information that benefits farmers and the soybean industry now and in the future.

I am proud that our farmer board members continue to invest and support multi-state and multi-disciplinary research, teaching and outreach. Researchers involved in large multi-university programs funded by NCSRP continue to address challenges, opportunities, and bringing value to soybean farmers. NCSRP research projects are focused in the areas of:

- genetics and breeding for increased yield potential and seed quality,
- integrated solutions for understanding and managing disease pathogens,
- innovations for combatting insect pests and weeds,
- on-farm agronomic solutions for improving cropping systems and profitability,
- the development and application of biotechnologies for soybean improvement, and
- maintenance of NCSRP's leadership role in productive partnerships with the United Soybean Board (USB) and other state and regional soybean checkoff organizations.

In this annual report we summarize some of the key research returns on NCSRP regional checkoff investments. I hope you enjoy reading this report and that you make a habit of finding more useful results and information on the Soybean Research and Information Network website (https://soybeanresearchinfo.com). Thank you for your time and interest in checkoff-funded soybean research.





NORTH CENTRAL SOYBEAN RESEARCH PROGRAM

1255 SW PRAIRIE TRAIL PKWY | ANKENY, IA 50023 | WWW.NCSRP.COM

funded by the soybean checkoff

An integrated approach to enhance durability of SCN resistance for long-term strategic SCN management (Phase II)

Funding: $588,370

Principal Investigator
Andrew Scaboo, University of Missouri

Co-Principal Investigators
Thomas Baum, Iowa State University
Andrew Severin, Iowa State University
Greg Tylka, Iowa State University
Melissa Mitchum, University of Missouri
Brian Diers, University of Illinois at Urbana-Champaign
Matthew Hudson, University of Illinois at Urbana-Champaign

Overview of project objectives
The soybean cyst nematode (SCN) is the most damaging pathogen to soybean production in North America. Although SCN-resistant soybean varieties are available to minimize yield loss, producers are faced with limited options for rotation once SCN develops in their fields. The lack of genetic diversity in SCN resistance has significantly increased the prevalence of SCN and reduced the effectiveness of current resistance sources. The team focused on two challenges that, when achieved, would enable scientists to develop more efficient SCN management practices. The first challenge is to increase the genetic diversity of SCN resistance in commercially available soybean varieties. The second challenge is identifying the SCN genes required for the adaptation to reproduce on resistant varieties and use these as markers to monitor nematode population shifts in the field.

Key results
The researchers focused on five main objectives. First, they worked on diversifying the genetic base of SCN resistance in soybeans and developing germplasm with new combinations of resistance genes. Field tests of soybean lines with new combinations of SCN resistance genes were grown in Illinois and Missouri. For the second objective, the research team worked on identifying SCN virulence genes to better understand how the nematode adapts to reproduce on resistant soybean varieties. Thirdly, they determined what combinations of resistance genes would be beneficial to enhance SCN resistance durability. Experimental lines containing various resistance gene combinations were tested in a greenhouse study. The fourth objective covered outreach and education of producers about this work. Objective five included coordination of testing the publicly developed SCN resistant lines.

Benefit to farmers
This research work will tremendously improve breeding efforts and will critically inform farmers' cultivar decisions. By creating a long-term management strategy for SCN management and germplasm development, farmers may have more alternatives in soybean cultivars that are SCN-resistant to combat this crop-devastating pest.

Links
An integrated approach to enhance durability of Soybean Cyst Nematode resistance for long-term strategic management
USB National Soybean Checkoff Research Database

Multi-pronged strategies to provide efficient, sustainable, and durable control to Sclerotinia stem rot

Funding: $90,000

Principal Investigator

Damon Smith, University of Wisconsin

Co-Principal Investigators

Daren Mueller, Iowa State University
Martin Chilvers, Michigan State University
Mehdi Kabbage, University of Wisconsin

Overview of project objectives

Sclerotinia stem rot of soybean (SSR) is a significant yield-limiting disease in the North Central region. Successful control of this disease requires farmer to use multiple tools in an integrated disease management plan including crop rotation using non-host crops, resistant cultivars, reduced tillage, modifying the soybean canopy through seeding rate and row spacing, and applying chemical control.
This project's objectives include:

- evaluating current soybean management practices for effectiveness
- identifying new germplasm lines resistant to *Sclerotinia sclerotiorum* that can be incorporated into soybean breeding programs
- refining the existing advisory tool to incorporate model output for different forms of SSR resistance, and
- developing outreach publications and tools including an electronic book to inform growers of SSR management.

Key results

The research team consolidated data from the last several years and examined how row spacing, plant populations and foliar fungicide applications affect the disease severity index (DIX) and soybean yield. The interaction of row spacing and planting population had a significant effect on both disease and yield. The DIX was lowest in 30-inch rows with less than 140,000 seeds/acre. The DIX was highest with populations of 200,000 seeds/acre in 15-inch rows. Fungicide application was most effective and yields highest when fungicide was applied at both R1 and R3 growth stages. But other factors need to be considered for field specific SSR management including field history and environmental conditions. In development of new germplasm for SSR resistance, the research team identified five lines with resistance to the white mold pathogen and they hope to identify another three to five lines from the 2020 field trials. The Sporecaster app was introduced in 2018 and since then it has been downloaded more than 3,500 times. Daily use ranged from 600-800 users per day during July and August. Major adjustments have been made to the app, especially to improve its performance in northwest Iowa. Other adjustments included improved weather accuracy and the ability of the user to adjust a spray action threshold. The updated version (1.35) is now available. Outreach publications have been updated and are available for downloading. Content for the electronic book is in development and the goal is to have it completed by the end of 2021.

Benefit to farmers

Farmers will gain more understanding of modern management strategies for Sclerotinia stem rot (SSR) including improved fungicide application timing through the use of an advisory tool, reducing unnecessary fungicide inputs, saving money and time and improving yield and profitability.

Links

Multi-pronged strategies to provide efficient, sustainable, and durable control to Sclerotinia stem rot *USB National Soybean Checkoff Research Database*

Boots on the ground: Validation of benchmarking process through an integrated on-farm partnership

Funding: $328,849

Principal Investigator

Shawn Conley, University of Wisconsin

Co-Principal Investigator

Patricio Grassini, University of Nebraska

Overview of project objectives

Analysis of data from a producer survey performed during the previous three-year NSCRP-funded benchmarking project (Benchmarking Soybean Production Systems in the North Central U.S.) revealed an average yield gap of 20-30 percent. A yield gap is the difference between current yield and potential yield as determined by climate, soil and genetics. The survey also revealed a number of agronomic practices that could be fine-tuned to close the yield gap and improve producer profit. This project focuses on showing how the data from the survey could be used to identify and evaluate management changes on farms in the North Central U.S. The project goal is to validate a novel research approach that uses self-reported on-farm production practices, with on-farm validation to identify management practices with the greatest impact on yield and profit. State-to-state research collaboration will be strengthened; and farmer-to-farmer networks will be built.

Key results

A kick-off meeting was held in November 2019 and a follow up meeting in November 2020 with project collaborators discussing objectives, logistics and protocols. On-farm research fields were identified, and trials began in Spring 2020. Data collection from the research trials is ongoing. To promote the work, live interviews on Twitter with participating farmers were held; an Extension publication, “Benchmarking Soybean Production Systems in the North Central U.S.” containing Year 1 results was distributed and has been shared with collaborators. Other professional manuscripts have been published or in the process for publication.

Benefit to farmers

The potential impact of the outcomes from this project is significant. On-farm validation of identified management strategies across the North Central region will impact 60 million acres of soybeans. For example, farmers within a region where planting date was a significant management factor, would realize a production increase of 4.7 million bushels per day (0.24 bu/acre/day yield increase on 19.5 million acres). This impact figure was estimated based on previous benchmarking project analysis of on-farm yield data.

Links:

Benchmarking soybean production systems in the North Central U.S. *USB National Soybean Checkoff Research Database*

Boots on the Ground: 2019 On-Farm Trials Report, *Wisconsin Soybean Marketing Board, 2019*

Discovering and finally understanding the functions of genes that underlie major agricultural traits in soybean

Funding: $60,000

Principal Investigator
Robert Stupar, University of Minnesota

Co-Principal Investigators
David Hyten, University of Nebraska– Lincoln

Overview of project objectives
The heart of this project focuses on developing soybean mutant genetic resources that will increase our understanding of the genes that underlie traits of agronomic importance. The development of these resources has been designed to overcome factors that have limited similar projects in the past such as issues with seed sources, seed purity, mutagenesis source, genotyping, phenotyping and seed storage. The new mutant resources will allow researchers to identify mutant stocks for their genes of interest by simply searching a genomic database that will be developed with this project. This will provide an unparalleled public resource in which researchers can quickly identify the mutations, order mutant seeds, and test the agricultural function and importance of genes.

Key results
This project addresses the goal of gene discovery and germplasm development for traits critical to soybean growers, namely yield enhancement and seed composition improvement. The project provides a new mutant genetic resource for public use, including breeding and gene discovery efforts. The advantages of having already identified mutations in specific genes will enable researchers to do targeted breeding and discovery work on genes with previously predicted or known functions.
To-date, some developments include:

- 4,300 M2-generation mutant plants have been phenotyped; M3 seed has been harvested and stored
- 50 plants have been sequenced at the whole-genome scale to identify all new mutations
- 220 new M2 plants with the MN1312CN background were grown to expand the size of this mutant population to provide greater genetic diversity. Researchers will be able to order seeds from this population in the future.

Benefit to farmers
The goal of this project is to develop enabling resources for gene discovery and germplasm development for traits critical to soybean growers, namely yield enhancement and seed composition improvement. The long-term benefit of these resources will be to enable breeding capacities to more effectively and efficiently improve soybean varieties for farmers.

Links
Discovering and finally understanding the functions of genes that underlie major agricultural traits in soybean
USB National Soybean Checkoff Research Database

Increasing soybean genetic gain for yield by developing tools, know-how and community among public breeders in the North Central US

Funding: $666,514

Principal Investigator

Leah McHale, The Ohio State University

Co-Principal Investigators

Asheesh Singh, Iowa State University
Dechun Wang, Michigan State University
Katy M. Rainey, Purdue University
Brian Diers, University of Illinois at Urbana-Champaign
Matthew Hudson, University of Illinois at Urbana-Champaign
Nicolas Frederico Martin, University of Illinois at Urbana-Champaign
Aaron Lorenz, University of Minnesota
Pengyin Chen, University of Missouri
Andrew Scaboo, University of Missouri
George Graef, University of Nebraska
David Hyten, University of Nebraska-Lincoln
Rex Nelson, USDA-ARS/Iowa State University

Overview of project objectives

The project has four main objectives to enhance gains for yield and seed composition in soybeans. First, the team will develop a breeding database that will be housed within SoyBase.org, the current repository for soybean genetics and genomic data. The team will also add environmental and genotypic data to the Northern Uniform Soybean Trials, which dates back to 1941. The second objective is focused on the development and use of low-cost genotyping technologies with high-quality marker data; and making tools available for genomic data management that integrates genomic data with phenotypic data in a user-friendly form. Objective Three will evaluate different breeding methods that target one or more areas of trait improvement such as yield and seed protein content. Breeders will test methods to determine which are most viable to improve genetic gains. The fourth objective is to follow up and complete the evaluation of diverse soybean genotypes from the USDA Soybean Germplasm Collection to obtain high-quality phenotype and environment data.

Key results

A new interface for the Northern Uniform Soybean Trials data has been developed. Work is being done to streamline a genotyping service for the public soybean breeding sector at costs low enough to afford genomic selection on a wide scale. For Objective Three, the team has collected or is collecting tissue samples, which could equal up to thousands of samples, and are sending them to the Hyten lab for genotyping.

Benefit to farmers

This work leverages and builds upon ongoing and previous work by developing tools, know-how and community among public breeders. The results will include greater genetic gains in soybean for yield, as well as any other targeted trait. This will translate to improved cultivars that will achieve higher yields and higher quality.

Links

Increasing Soybean Genetic Gain for Yield by Developing Tools, Know-how and Community Among Public Breeders in the North Central US *USB National Soybean Checkoff Research Database*

Soybean entomology research and Extension in the North Central region

Funding: $368,406

Principal Investigator

Kelley Tilmon, The Ohio State University

Overview of project objectives

This project involves collaborative research among 25 researchers in 13 states, working on four main program areas:

I. Extension/outreach and farmer feedback
II. Insect management and profitability
III. Aphid resistant varieties and virulence management
IV. Insect monitoring.

The objectives within these programs address the efficient, cost-effective management of defoliating (chewing) insects; the role of cover crops relative to insects in soybean production; aphid resistance to insecticides (a documented and growing problem in the region); a new objective focusing on soybean stem borer (Dectes); the ability of honey bees to improve soybean yield; a public-private partnership with Corteva to advance aphid-resistant soybean varieties for wide scale commercialization; advances in soybean breeding for aphid resistant varieties; regional monitoring programs for pest and beneficial insects; and a survey program to assess farmer priorities and needs to inform future research and Extension. In addition, we have an Extension objective with a dedicated budget line to produce deliverables and disseminate project results.

Key results

Work has begun on the updated, second edition of the "Stink Bugs of the North Central Region" field guide. Electronic versions of several other publications are being prepared including a publication on pollinators found in soybean in the North Central region. Field samples were taken in six states in preparation for a guide on defoliating insects in soybeans.

Work on the component of pest and beneficial insects in cereal rye cover crop prior to soybean was conducted in 2020, but the number of sites were reduced because of the COVID-19 pandemic. No significant pest pressure was reported at any of the sites; increased insect activity was seen where cover crop termination was delayed.

Two colonies of honey bees were installed near the center of six soybean fields in Ohio to evaluate the effect of bee pollination on soybean seed production. Colonies in four fields had significant honey buildup during soybean bloom. Bee visitation frequency was recorded for the floral attractiveness traits in soybeans. Cage experiments were done with two highly attractive and two unattractive soybean varieties. This was done to evaluate honey bee foraging preferences and to quantify the effect of honey bee pollination on soybean yield. Yield differences are being studied between the four varieties.

Studies were done on insecticide-resistant soybean aphids as well as the soybean stem borer and data are being finalized for both areas. Studies are also being conducted with breeding aphid-resistant soybean varieties. The varieties were field-tested in four states with aphid populations found to be significantly below the threshold on the resistant cultivars.

Benefit to farmers

The objectives within this research project address efficient, cost-effective insect management for farmers. Soybean insect pests not only reduce yield, but can reduce grain quality, altering oil and protein content and thus affect soybean value. The collaborative work for this project includes state Extension outreach and farmer feedback, insect monitoring and management and exploring aphid-resistant varieties.

Links

Soybean Entomology Research and Extension in the North Central Region *USB National Soybean Checkoff Research Database*

Manipulating a major gene governing seed reserves as a means to maintain yield and oil while increasing protein

Funding: $55,425

Principal Investigator

Matthew Hudson, University of Illinois at Urbana-Champaign

Overview of project objectives

The research team had previously fine-mapped the high-protein Quantitative Trait Locus (QTL) and identified a gene on the basis of this QTL. This project furthers the research to develop the higher-protein soybean. Through greenhouse-grown populations and yield trials the researchers will attempt to recreate the high-protein phenotype using CRISPR/Cas9 to further their knowledge of this locus on chromosome 15.

Key results

Field trials were completed for two growing seasons and data is being analyzed. Early indications show that one transgenic event increased protein and free amino acid levels while oil content was not affected, but this still may be statistically insignificant. The effect on protein and oil tested in the greenhouse and in field trials with the down-regulated high protein allele showed a 1-2 percent increase in protein in the best lines. Further field experiments are in progress to see the effects on maturity and seed mineral content in the transgenic field trials. A manuscript is being written describing the identification of the gene and its role in controlling oil and protein levels.

Benefit to farmers

An evaluation of soybean varieties released between the 1920s and 2010 showed that seed protein content has reduced by about 2 percent. This reduction makes it difficult for crushers to produce soybean meal with 48 percent protein, which is the industry standard. While 2 percent doesn't seem to be significant, the world soybean crop is around 370 million metric tons, thus a single percentage point in protein concentration represents 3.7 million tons. Growing soybeans with increased protein will improve the crop's value for growers.

Links

Manipulating a major gene governing seed reserves as a means to maintain yield and oil while increasing protein *USB National Soybean Checkoff Research Database*

Non-transgenic generation of herbicide resistance in soybean using CRISPR base editing

Funding: $94,901

Principal Investigator

Feng Qu, The Ohio State University

Overview of project objectives

This project strives to address the challenges posed by weeds in North Central soybean fields, which are becoming harder to control, primarily due to spreading of weeds resistant to herbicides that are usable on soybeans. By equipping soybeans with new tolerance traits against herbicides not currently used on soybeans, more choices of herbicides with diverse modes of action will be made possible. Using CRISPR-based gene editing, we hope to create new herbicide tolerance traits by introducing precise changes to a select set of soybean genes. Modifying three soybean genes would enable tolerance to corresponding herbicides Imazapyr, fluridone, and mesotrione.

Key results

Progress is being made, even though the COVID-19 pandemic forced the closure of the research labs for more than 10 weeks and much of the tissues and materials were lost. Because of this, new protocols are under development, which, if successful, will be simpler, technically less demanding and shorten the time needed for producing transgenic materials. The research team has incorporated a new base editor, the latest version of base editing Cas9. They are in the process of engineering herbicide tolerance in soybeans using alternative approaches including trying to adopt a rice herbicide tolerance gene in soybean.

Benefit to farmers

The successful outcomes of this project will be soybean seed stocks equipped with three new herbicide tolerance traits, which could be separate or combined into the same seed. Soybean growers would be able to use three novel classes of herbicides that are not currently used on soybeans, thus broadening herbicide choices and flexibility for farmers. This will, in turn, lead to higher soybean yields and productivity.

Links

Non-transgenic generation of herbicide resistance in soybean using CRISPR base editing *USB National Soybean Checkoff Research Database*

Expanding the SCN Coalition

Funding: $160,000

Principal Investigator

Samuel Markell, North Dakota State University

Co-Principal Investigators

Kathy Lawrence, Auburn University
Edward Sikora, Auburn University
Paula Agudelo, Clemson University
John Mueller, Clemson University
Gary Bergstrom, Cornell University
Kaitlyn Bissonnette, Iowa State University
Gregory Tylka, Iowa State University
Douglas Jardine, Kansas State University
Paul (Trey) Price, Louisiana State University AgCenter
George Bird, Michigan State University
Marisol Quintanilla, Michigan State University
Tom W. Allen, Mississippi State University
Clarissa Balbalian, Mississippi State University
Lindsay Thiessen, North Carolina State University
Guiping Yan, North Dakota State University
Albert Tenuta, Ontario Ministry of Agriculture-Food & Rural
Alyssa Collins, Pennsylvania State University
Paul Esker, Pennsylvania State University
Darcy Telenko, Purdue University
Emmanuel Byamukama, South Dakota State University
Jason Bond, Southern Illinois University at Carbondale
Anne Dorrance, The Ohio State University
Travis Faske, University of Arkansas
John Rupe, University of Arkansas
Alyssa Koehler, University of Delaware
Robert Kemerait, University of Georgia
Melissa Mitchum, University of Georgia
Nathan Kleczewski, University of Illinois at Urbana-Champaign
Nathan Schroeder, University of Illinois at Urbana-Champaign
Carl Bradley, University of Kentucky
Seth Naeve, University of Minnesota
Loren Giesler, University of Nebraska
Shawn Conley, University of Wisconsin
Ann MacGuidwin, University of Wisconsin
Damon Smith, University of Wisconsin
Hillary L. Mehl, Virginia Tech

Overview of project objectives

This project intends to assure long-term success of the SCN Coalition. The objectives are to increase grower and industry awareness of the increasing threat; to unify straightforward management recommendations and their communication; and ultimately slow the erosion of PI 88788 effectiveness. Development of the SCN Coalition is directly linked to the support from the North Central Soybean Research Program (NCSRP), whose resources have been leveraged extensively to secure support from the United Soybean Board and corporate partners.

Key results

Outreach efforts to farmers, researchers and industry about SCN education and management have increased dramatically over the last two years. Twitter and Facebook response has grown, as well as those visiting the SCN Coalition website. Other outreach efforts include news releases, Extension activities including field days, winter meetings, SCN sampling programs, trade shows and more. The most recent effort is the YouTube video series “Let’s Talk Todes,” with 23 episodes available for viewing. A special recognition of note is the 2020 Best of Show in Public Relations award presented by National Agri-Marketing Association (NAMA).

Benefit to farmers

The SCN Coalition is conducting an SCN Resistance Management and Awareness Campaign to educate growers and industry on the reality of SCN resistance development, to slow the development of highly aggressive SCN populations, and to minimize increasing levels of yield loss.

Links

Second SCN Coalition: Resistance management and awareness campaign *USB National Soybean Checkoff Research Database*

www.thescncoalition.com

Soybean gall midge: Surveying the North Central region, adult monitoring and host plant resistance

Funding: $162,953

Principal Investigator

Justin McMechan, University of Nebraska

Overview of project objectives

Although soybean gall midge was recently identified and designated a significant pest of soybean, it had been in isolated Nebraska fields since 2011. By 2018, yield losses were most extensive in Nebraska, Iowa, South Dakota and Minnesota. Emergency funding from the North Central Soybean Research Program in 2019 provided researchers in these states to track soybean gall midge emergence to find the extent of its presence.

This project intends to achieve four objectives:

I. Determine the distribution and severity of soybean gall midge across the region
II. Determine the emergence timing and source of the soybean gall midge
III. Screen soybean varieties for resistance or tolerance to the soybean gall midge
IV. Disseminate information to stakeholders on current information and soybean gall midge management.

Key results

Field surveys for soybean gall midge were conducted in Illinois, Iowa, Kansas, Minnesota, Nebraska, Minnesota, Missouri and South Dakota. COVID-19 limited the ability to conduct surveys in the rest of the region but will be conducted in 2021. Based on the completed surveys, no previously un-infested states detected soybean gall midge presence, but there was continued expansion in Iowa, Minnesota, Missouri, Nebraska and South Dakota. Monitoring for adults began on March 1 in Nebraska, and on May 1 in Iowa, Minnesota and South Dakota. On June 10, adults were detected in Cass County, Neb., followed by rapid emergence in the other locations. Duration of adult emergence was an average of 25.6 days, longer than the previous year of 16 days. The proportion of adults collected was similar to 2019 except in east-central Nebraska where there was a 229 percent increase. This provided an opportunity to test a wide range of products and control strategies. No tested product provided complete control, however one product applied at planting provided a significant level of protection. A summary of these products is being prepared. Soybean lines were tested at two Nebraska sites and one Iowa site for soybean gall midge resistance. Significant soybean gall midge pressure was found on all lines. A website was established to provide a central location for growers and Extension personnel to find information, alerts and more. An alert network was created to notify growers through email, phone calls and text messages. To-date, users from seven states have registered.

Benefit to farmers

Soybean farmers will benefit from knowing whether or not soybean gall midge has reached their area. By continued study of this pest, farmers will have the knowledge of what management practices, insecticides and resistant lines to use to mitigate the soybean gall midge from damaging their crops and yield.

Links

Soybean Gall Midge: Surveying the North Central Region, Adult Monitoring and Host Plant Resistance *USB National Soybean Checkoff Research Database*

SoybeanGallMidge.org

Developing an integrated management and communication plan for soybean sudden death syndrome

Funding: $137,000

Principal Investigator

Daren Mueller, Iowa State University

Overview of project objectives

Sudden death syndrome (SDS) is an annual threat in most of the North Central region. In 2014, this disease alone caused an estimated loss of nearly 62 million bushels in the U.S., valued at approximately $617 million. The foundational management strategy for SDS in soybean is using resistant cultivars. But it is evident that resistance alone does not provide adequate disease control. The goal for this project is to investigate management options to help ensure resistant cultivars will be as effective as possible.

In a previous project, we looked at the effect of soybean cyst nematode (SCN) management on SDS severity and found that SCN resistance played a critical role on SDS development. Fall season SCN population and SDS were positively correlated. The SCN resistant cultivar PI 88788 has not been keeping nematode populations in check, but results showed that any resistance to SCN led to greater yields, lower SDS and lower SCN reproduction than cultivars with no resistance.

The project objectives include:

- determining how fungicides and nematicide seed treatments affect SDS and SCN
- field evaluation and management of SDS and understanding side effects on *Fusarium virguliforme* population and soil health
- developing models to quantify the negative yield impacts of SDS foliar symptoms and root rot
- studying genetic and virulent variability of *Fusarium virguliforme* using diverse soybean varieties and resistance mapping for foliar yellowing and death
- communicating these results to farmers, agribusiness and other soybean stakeholders.

Key results

Numerous manuscripts have been published based on this project and previous related project results. To communicate results to other researchers and students, several outreach efforts have been done including: a summary report from field-testing the effect of seed treatments on SCN, SDS and yield was presented in Southern Soybean Disease Workers meeting, Pensacola, Florida; poster was presented in virtual annual 2020 APS meeting; presented research reports at group meetings, winter meetings, ICM conferences, on Crop Protection Network, many state or province level talks, seminars, media interviews, field days and conferences for farmers; published articles in state newsletters, several media releases etc.; information was also uploaded to Soybean Research & Information Network.

Benefit to farmers

Results from this project will help farmers to best manage sudden death syndrome in their soybean fields.

Links

Developing an integrated management and communication plan for soybean Sudden Death Syndrome *USB National Soybean Checkoff Research Database*