NORTH CENTRAL SOYBEAN RESEARCH PROGRAM

2017 ANNUAL REPORT

WHO WE ARE

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 continues to be 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.

NCSRP 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. NCSRP 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 state QSSB's and with the USB in order 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 disemination of research resuklts through appropriate peer reviewed scientific meeting abstracts and journals, Extension publications, farmer-focused bulletins, appropriate websites (Soybean Research &Informationm Initiative) and databases (National Soybean Checkoff Research Database)

COLLABORATIVE SOYBEAN RESEARCH OBJECTIVES AND PRIORITIES:

1. Soybean yield enhancement through genetic improvement and biotic and abiotic stress mitigation for the 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) of consistent or potentially significant economical 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 address soybean response to water, nutrient, 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.
   - Corn/soybean rotations
   - Plant populations, row spacing and input management
   - Water quality and watershed planning
   - Cover crops
   - Soybean production sustainability and life cycle assessment

COMMENTS

FARMERS

KEITH KEMP, OHIO
NCSRP has been at the forefront of promoting collaboration among state soybean boards, industry and universities in addressing soybean production challenges such as insect and disease pressure, production practices and other challenges facing today's soybean farmers. NCSRP has effectively worked to minimize redundant research thus maximizing farmer dollars.

JERED HOOKER, ILLINOIS
Recently, the NCSRP Directors; to improve communication and collaboration, have urged multi-state, multi-year projects. This seems to be in the best interest of soybean farmers in the 12 NCSRP states, who produce 85% of US soybeans, and sponsor the research.

STAFF

MARK SEAMON, MICHIGAN
Many of our soybean production issues are larger than our state can handle alone. NCSRP has allowed Michigan soybean growers to be aware of, identify and manage crop pest issues before they get to crisis status in our state. Because pest prevention and the protection of crop yield are such critical factors in harvesting optimal crop yields, early awareness and action are essential. Michigan soybean growers have battled soybean cyst nematodes for almost three decades. This issue crosses state borders and requires the collaborative efforts that a regional program offers.

TOM FONTANA, OHIO
The best thing about NCSRP is that 12 states work together on region-wide issues, pooling resources and using incredible research talent collaboratively in areas critical to the future success of soybean farmers.

DAVID KEE, MINNESOTA
NCSRP is a great, cooperative effort between universities, state soybean boards and farmers. Each group brings a unique point of view to the table.

KENDALL NICHOLS, NORTH DAKOTA
I think in the future NCSRP will continue to lead the nation in addressing the most important issues facing the soybean industry. I think this will lead to NCSRP becoming more influential nationally.

KEITH SMITH
In my opinion, the major accomplishments in the last 25 years of NCSRP are leadership in developing a public gene mapping effort, leadership to initiate the SCN Coalitions and group efforts to coordinate white mold, sudden death syndrome, iron deficiency chlorosis, aphids, seedling diseases and soybean production practices research. All of these activities had their origins in NCSRP.

LEADING THE EFFORT.

FROM THE PRESIDENT

In 2017 the North Central Soybean Research Program (NCSRP) celebrated its 25th anniversary. It is amazing what this organization has accomplished during that time.

When NCSRP began in 1992 there wasn't a lot of communication happening between the state soybean boards or the universities they funded. While soybean issues like aphids and SCN crossed state lines, the research to combat the pests didn't. The NCSRP organization facilitated discussions between researchers and farmers in the Midwest and across the country to work together to reduce research duplication and further stretch our checkoff dollars.

One of the NCSRP projects I'm most proud of is the group's work with soybean aphids. We pulled many states into that project and finally got the message out that you don't have to treat aphids if you only see one or two. The research proved the 250-aphid economic threshold was accurate and now we know we don't always need to spray – and we're saving money.

The soybean aphid project shows how NCSRP research has benefitted farmers. It is also a great example of the collaboration among a variety of universities and researchers. All 12 NCSRP member states had researchers involved with the aphid project at some point. This means the results will be applicable for all our farmers, regardless of state boundaries.

While we celebrate our successes, it is also important we keep our minds on the future. NCSRP positions itself to help with small problems before they become big ones. A few years ago, the issue was soybean rust. NCSRP helped fund research that showed how it spread, how to treat it, and whether it was the threat everyone believed it could be. Looking forward, we're going to continue that kind of success.

We know what we need to get done. We know we need to continue supporting regional research. There seems to be something new that comes along every year – biologicals are a new and exciting area of research and there's always some new pest out there.

Throughout the following pages I hope you get a sense of the type of research NCSRP has supported on farmers' behalf and the magnitude of the impact NCSRP has had over the last 25 years. It is an organization I am proud to be involved in, and I hope by reading this annual report you can see why.

I look forward to taking on new issues with NCSRP and continuing to serve the farmers of the North Central region in 2018.

Gene Stoel
NCSRP President

NCSRP NORTH CENTRAL SOYBEAN RESEARCH PROGRAM

FROM THE EXECUTIVE DIRECTOR

Welcome to the North Central Soybean Research Program (NCSRP) 2017 Annual Report. NCSRP is a regional soybean checkoff program dedicated to investing in basic and applied soybean research and the translation of that research into practical solutions for Midwestern soybean farmers. Each year, farmer board members representing the 12 NCSRP-member states leverage their technical expertise and vision for increasing soybean yields and profitability. They do this by prioritizing, funding and communicating approximately three million dollars' worth of soybean research and extension work. This annual report provides an overview of how member states' soybean checkoff dollars are invested and highlights some of the interesting and meaningful work that has provided a return on that investment.

The year 2017 was especially exciting for NCSRP as the organization celebrated its 25th anniversary. This celebration year included additional publicity for the program in several state soybean association magazines, promotion of funded research and resulting information and solutions presented on the Soybean Research & Information Initiative (SRII) website and through publications, meetings and field days. The celebration year concluded with a reception and dinner with current and past farmer board members, state soybean staff and university researchers.

Thank you for taking time to read the 2017 NCSRP Annual Report and thank you for your continued support of the program. Here's to 25 more years of NCSRP leadership and success!

Ed Anderson, Ph.D.
eanderson@iasoybeans.com

2017 NCSRP BOARD OF DIRECTORS

GENE STOEL
PRESIDENT
Lake Wilson, Minnesota

MIKE CERNY
SECRETARY/TREASURER
Sharon, Wisconcin

CECIL DEMOTT
VICE PRESIDENT
Rock Port, Missouri

ED CAGNEY
Scotts, Michigan

CRAIG CONVERSE
Brookings, South Dakota

MATT DANUSER
Marion, North Dakota

JERED HOOKER
Clinton, Illinois

KEITH KEMP
West Manchester, Ohio

RON OHLDE
Palmer, Kansas

DAVE RODIBAUGH
Rensselaer, Indiana

SUZANNE SHIRBROUN
Farmersburg, Iowa

LARRY TONNIGES
Utica, Nebraska

RESEARCH.

RESEARCH STEPPING STONES

While research projects have a starting point and a conclusion, rarely does the usefulness of the data stop when the research ends.

A few years ago, Ahmad Fakhoury, Ph.D., and his lab at Southern Illinois University (SIU) were part of a large soybean seedling diseases project. When that project ended they still had all the fungal isolates from the study. When the group realized some of the isolates are not usually associated with disease, a new research project began.

"Collaborators (in the seedling disease project) would send SIU samples they isolated from diseased seedlings and then we would identify them. We have around 3,000 isolates in the collection," said Fakhoury, an associate professor at SIU. "We went back and looked at them and a couple hundred isolates are not usually considered as pathogens of soybean. So we thought maybe there is another reason why they were isolated from diseased soybean plants. Could they be potential biocontrol agents?"

Biocontrol agents are organisms present in the soil that provide protection to plants against pathogens. They do this by antagonizing plant pathogens and sometimes, by also enhancing plant health. Fakhoury partnered with researchers from Iowa, Kentucky and Michigan to analyze the isolates and determine if some of them

> "COLLABORATORS (IN THE SEEDLING DISEASE PROJECT) WOULD SEND SIU SAMPLES THEY ISOLATED FROM DISEASED SEEDLINGS AND THEN WE WOULD IDENTIFY THEM. WE HAVE AROUND 3,000 ISOLATES IN THE COLLECTION."
>
> **— AHMAD FAKHOURY**

IT'S WHAT WE DO.

could be acting as biocontrol agents and having a positive effect on the plant.

The group conducted growth chamber tests applying the potential biocontrol agent to the plant and then exposing it to the pathogen to see what the interaction would be. Through this process, the group identified several organisms that showed control against seedling disease pathogens for common diseases like sudden death syndrome (SDS), fusarium root rot and rhizoctonia, among others.

"Of the hundreds of pathogens, six seemed to be pretty potent," said Fakhoury. "These isolates can affect the soybean pathogens in different ways."

Some of the biocontrol agents compete with the pathogens for resources and nutrients and then outgrow them. Other biocontrol agents attack the pathogen directly, but both types have positive impacts on the growing plant.

continued on page 8

Researchers wanted to see how much of an effect these biocontrol agents had by themselves and if there was a greater effect when they were combined. The level of protection of the various combinations of agents was first tested in a lab, and then tested in the field this past growing year. In Illinois, the combinations and solo treatments were tested against SDS and charcoal rot. Locations in Michigan and Iowa tested for protection against Pythium.

The selected locations had various disease histories, soil types and tillage practices, allowing the researchers to analyze the efficacy of the biocontrol agents across a variety of management practices.

> "WE'RE LOOKING AT HOW DIFFERENT MANAGEMENT PRACTICES COULD IMPACT THE ACTIVATION OF THE AGENTS AND HOW THAT MIGHT AFFECT THE LEVEL OF PROTECTION THEY OFFER."
>
> **— AHMAD FAKHOURY**

"We wanted to determine if these biocontrol agents affected the pathogens, and they do. Then we wanted to identify if there were certain conditions that would be conducive to the relationship between the different agents in the field," said Fakhoury. "We're looking at how different management practices could impact the activation of the agents and how that might affect the level of protection they offer."

There will be multiple ways for this research to benefit farmers. Fakhoury and his research group have been working with a couple companies to see if there is interest in some of the agents they have worked to isolate. Companies could then take this information about these biocontrol agents and turn it into products farmers could use to improve disease resistance.

Perhaps the biggest benefit of this research is the effect it could have on future research. Understanding how these specific biocontrol agents protect soybean plants, either by enhancing the plant's own defenses or by attacking the pathogens, would be enormously beneficial to researchers working to understand the relationships between pathogens and plants. In addition, determining the management practices that help improve the native population of beneficial agents in the soil would also improve production. If farmers could encourage the growth and development of these beneficial organisms without adding another application, they could save money and increase their disease resistance.

This research on biocontrol agents may have started from the results of a previous study, but it could positively influence future research all on its own. Effective biocontrol agents can mean big things for integrated approaches to improve soybean productivity.


Identification of Potential Biological Control Agents (BCAs)
• What is biological control?
• Component of integrated management of plant disease
• Mechanisms of action (Direct vs. Indirect)
Objectives:
• Screen a collection of
against soybean
NCSRP

COMBATING IRON DEFICIENCY CHLORSIS

When a human body is low in iron, a simple iron capsule can raise their level. For soybeans, the process is a bit more complex. Iron deficiency chlorosis (IDC) is a major soybean yield robber for more than half of the states in the North Central Midwest. This is due to the high pH soils deposited throughout the region by glaciers thousands of years ago and the tendency for these areas to have wet springs.

"In South Dakota, IDC is one of the most important yield inhibitors," said one South Dakota farmer to Phillip McClean, Ph.D., professor at North Dakota State University and principal investigator for "Iron deficiency chlorosis: Getting to the root of the problem."

McClean elaborated on the farmer's comment, "It's a very complex problem influenced by weather patterns and the physiological processes involved with moving iron out of the soil and into the plant."

The complicated process McClean refers to is a five-step progression each plant must go through to get iron from the soil to its leaves. First, to separate the iron from the soil particles, the plant must release acid into the soil. The soil then releases iron in an Fe(III) state and the plant must convert it to an Fe(II) state to use it. The third step involves the iron crossing the root tissue and entering the plant itself. Once inside the plant, the iron is transported into the xylem or water tubes of the plant. For the fifth and final step, the iron must bind to an acid molecule to be brought to the leaves.

If anything goes wrong throughout this lengthy process, the iron won't get to the plant's leaves where it is most needed. Without the correct amount of iron, soybean plant leaves will turn yellow, reducing the plant's ability to create the energy it needs to grow and develop. These symptoms show up in the first few weeks of leaf development, but can impact growth, and yield throughout the season.

"We're looking at the yellowing of the leaves and statistics show even a little yellowing for a long period of time can end up reducing a percentage of yield," said McClean. "Anything we can do to slightly reduce the yellowing is going to have a yield impact."

The five-step process to get iron to soybean leaves is just one of the reasons there isn't a "quick fix" for the iron deficiency problem. While analyzing the soybean genome, McClean and his co-investigators found seven different genomic regions with a factor related to IDC, affirming the complexity of battling this disorder.

"Finding the seven different IDC-related regions of the genome confirmed what we anticipated, that it wasn't going to be that simple," said McClean. "It would be nice if there was a magic gene, but everyone in the field knows that's not the case. It's more complex and that makes it difficult to work with."

> "WE'RE LOOKING AT THE YELLOWING OF THE LEAVES AND STATISTICS SHOW EVEN A LITTLE YELLOWING FOR A LONG PERIOD OF TIME CAN END UP REDUCING A PERCENTAGE OF YIELD."
>
> **— PHILLIP MCCLEAN**

McClean and his team of researchers from Minnesota, Nebraska, Iowa and North Dakota, analyzed samples from 30 different breeding programs to identify the molecular markers involved with the IDC response. Working with the breeding programs is a large part of this project, especially moving forward. Identifying the various genetic regions related to IDC-resistance was a great success for McClean and his team, but the long-term goal was to identify the specific genetic factors or genes and provide that information to the public and to private breeding programs.

"The reason we provide the information to private breeding programs is because 95 percent of soybeans grown today are bred by private companies," McClean said. "Not a lot of varieties in the field are bred by universities, so our goal was to get the information out there for those companies and their programs to improve the traits available to farmers."

Information like the kind McClean and others collect is useful for a variety of reasons, such as consistency across many environments and offering a proxy for field screening. It saves these programs money and time, meaning farmers can get the information and products they need faster.

MICRONUTRIENTS FOR SOYBEAN PRODUCTION IN THE NORTH CENTRAL REGION

Big things can come in small packages and micronutrients in the soil are no exception. Though only needed in small amounts, micronutrients such as boron, copper, iron, manganese, zinc and others are essential to plant growth and vitality. With concern that increasing soybean yields may be depleting soil nutrients and driving a need for fertilization, producers and crop advisers have been seeking current, reliable information about micronutrients.

With checkoff funding provided by the North Central Soybean Research Program (NCSRP), a team of agronomists and soil fertility experts from Indiana, Iowa, Kansas, Minnesota and Wisconsin studied hundreds of field trial results and collaborated to summarize existing knowledge about micronutrient management within the region. They also identified areas where information is unreliable.

The research findings and management guidelines are summarized in the regional publication "Micronutrients for Soybean Production in the North Central Region." The resource assists farmers and crop advisers with a thorough discussion of micronutrient needs for soybeans based on information compiled from response-based field studies throughout the region. The publication also includes research on the value of soil and plant tissue analyses to determine micronutrient needs.

"Our comprehensive review of research and numerous discussions across states led to a general agreement about the status of micronutrients for soybean in the region," said Antonio Mallarino, Ph.D., Iowa State University research and extension agronomist and principal investigator on the project. "We've talked about these potential issues for decades, but we now have a strong, sound base in what we are saying about micronutrients because of this collaborative project."

Mallarino highlighted several research findings from the study. One of the most encouraging is that micronutrient deficiencies in soybean plants throughout the North Central region are uncommon. This is because most soils have naturally adequate levels of micronutrients, with the exception of iron and manganese in certain soils, and some fertilizers and manure also contain micronutrients.

For fields that do have a deficiency there could be a variety of reasons. One of the suspected culprits, high-yielding soybean fields, was not one of those reasons. While high-yielding soybeans can remove large amounts of micronutrients, yield potential is not a good indicator of the need for supplemental fertilization with micronutrients.

Soybean iron deficiency chlorosis is commonly observed in calcareous soils present mainly in western areas of the North Central region. The use of tolerant varieties and recently developed fertilizers are good options for farmers with this issue to alleviate the impact of iron deficiencies, although typically the yield level achieved is less than in field areas that are not calcareous. Fields with a manganese deficiency in soybean plants is observed mainly in coarse-textured soils that are common only in a few states and in other soils found mainly in Indiana, Michigan and Ohio. In these soils and conditions, manganese fertilization is recommended.

> "MICRONUTRIENT DEFICIENCIES IN SOYBEAN PLANTS THROUGHOUT THE NORTH CENTRAL REGION ARE UNCOMMON."
>
> **— ANTONIO MALLARINO**

The study examined relationships between micronutrient concentrations in soybean and amounts removed from the soil. A look at boron, copper, manganese, zinc and others suggested that there are no widespread or consistent micronutrient deficiencies in the North Central region. However, farmers should visually monitor their fields for symptoms and collect tissue and soil samples if necessary to address rare, but potentially significant issues.

"The nutrient deficiencies are different in every state, and even in different areas of the same state because of soil types and climate," said Mallarino. "While you could make the case for each state having its own guide to micronutrients, partnering with other states was vital in confirming that what we're saying is common throughout all the states."

WHITE MOLD RESEARCH PAYING OFF

Researchers have found ways to curb white mold losses and possibly make the disease a non-issue for North Central soybean farmers.

A three-year study titled "Biology and Control of Sclerotinia Rot (white mold) of Soybean," funded by the North Central Soybean Research Program (NCSRP), addresses host resistance, factors affecting fungicide efficacy, and outreach and disease management strategies. Four NCSRP states are collaborating on the project including Iowa, Michigan, Nebraska and Wisconsin.

Mehdi Kabbage, Ph.D., principal investigator, said the $270,000 study has yielded promising results.

"We've learned there are some chemistries that control white mold well, but one day we're hoping farmers won't even have to spray for it," said Kabbage, an assistant professor of plant pathology at the University of Wisconsin-Madison specializing in plant-fungal interactions.

During the study's first two years, scientists discovered the most effective fungicides and application times for white mold. They also found genes that can be "turned off" to make soybeans resistant to the disease. Work continues this year to:

- Test new transgenic soybean plants resistant to white mold in greenhouses and fields
- Develop a new smart phone app for farmers to assist in timely fungicide spraying
- Develop updated, grower-centric, economic and outreach materials.

While a sporadic problem for North Central farmers, white mold is costly. From 2010-14, scientists said yield losses exceeded 100 million bushels. At $9 per bushel, that's nearly $900 million.

White mold is caused by a soil fungus Sclerotinia sclerotiorum. Cool, moist conditions at flowering (R1-R3) are most conducive to disease development. White cottony mycelia (moldy growth) indicates its presence.

The disease, sometimes referred to as sclerotinia stem rot, girdles the soybean stem and disrupts the transport of water and nutrients within the plant causing yield loss — 5 to 10 percent is typical though severe cases can reach 50 percent or more.

"I know of a field in Michigan that was wiped out, which is scary," Kabbage said. Research indicates Approach® and Endura® chemistries provide the best protection, he said. Scientists also developed a prediction model to tell farmers when conditions are conducive for fungal spore release for timely fungicide applications.

> "WE'VE LEARNED THERE ARE SOME CHEMISTRIES THAT CONTROL WHITE MOLD WELL, BUT ONE DAY WE'RE HOPING FARMERS WON'T EVEN HAVE TO SPRAY FOR IT."
>
> **— MEHDI KABBAGE**

"Timing is important," Kabbage said. Researchers identified four soybean NADPH oxidase genes that can be silenced to bolster white mold resistance in soybeans. Kabbage said the science is sound and expects it to be in commercial varieties in the near future.

"Our overall goal is to develop highly resistant varieties so we don't have to worry about white mold in the future," Kabbage said.

Photos courtesy of Iowa State University

SDS UPDATE

As soybean sudden death syndrome (SDS) continues to spread throughout the North Central region, so too does the need for early education and improved awareness among producers to mitigate the disease.

"Aside from soybean cyst nematode (SCN), SDS is likely the most devastating disease across the Midwest for soybeans," said Daren Mueller, Ph.D., associate professor and extension plant pathologist at Iowa State University (ISU) and principal investigator for the project. "The difference between SDS and SCN is that a field might look like it's going to yield a good crop until August, then SDS completely catches the farmer off-guard. SCN may not ever cause obvious symptoms as it negatively impacts yields."

For the project, An Integrated Management and Communication Plan for Soybean Sudden Death Syndrome, five NCSRP states (Indiana, Iowa, Michigan, South Dakota and Wisconsin) collaborated under a shared goal to ensure that SDS-resistant cultivars will be as effective as possible, even in a year unusually conducive to SDS conditions.

To achieve this, researchers identified several objectives:

1: Determine how seed treatments, in-furrow and foliar fungicides will affect SDS
2: Explore the effect of cultural practices on Fusarium virguliforme — the soilborne fungus causing SDS — and the development of the disease
3: Develop simple, cost effective tools for detection of Fusarium virguliforme in the field
4: Develop models to quantify the negative yield impacts of SDS in response to disease and inoculum intensity at the plant and field scales

Project researchers continue to work toward these objectives with the intent to communicate the results with farmers, agribusinesses and other soybean stakeholders.

The research team completed studies evaluating variety selection, planting dates and seed treatments to manage SDS. While variety selection and planting date results varied, seed treatments with fluoyram seemed to generally protect soybeans from SDS.

"After farmers decide on management practices, there are not a lot of in-season things that can be done to reduce SDS," said Mueller. "The farmer should do his or her homework when selecting seed treatments. Hopefully this project can give some clearer answers into those decisions."

"AFTER FARMERS DECIDE ON MANAGEMENT PRACTICES, THERE ARE NOT A LOT OF IN-SEASON THINGS THAT CAN BE DONE TO REDUCE SDS."

— DAREN MUELLER

NCSRP co-investigators for the project include Leonor Leandro and Yuba Kandel (ISU), Kiersten Wise (University of Kentucky), Martin Chilvers (Michigan State University), Damon Smith (University of Wisconsin-Madison), and Febina Mathew (South Dakota State University).

Additional collaborators include Carl Bradley (University of Kentucky) and Albert Tenuta (OMAFRA, University of Guelph, Canada).

NEW SOURCES OF RESISTANCE TO SOILBORNE DISEASES IDENTIFIED

A three-year research project funded by the North Central Soybean Research Program (NCSRP) will eventually reduce soybean losses caused by several soilborne diseases.

The $362,000 study, "Characterization and Enhancement of Soybean Genetic Resources for Soilborne Disease Resistance," wrapped up in December. The goal was to characterize, identify and/or isolate novel genes conferring resistance or partial resistance to Phytophthora sojae, Pythium ultimum, Pythium irregulare and Fusarium graminearum.

James Kurle, Ph.D., principal investigator, considers the project a success.

"We were able to identify markers for these resistance genes that will help or enable us to breed varieties that will be more tolerant or partially resistant to these soilborne pathogens," said Kurle, an associate professor of plant pathology at the University of Minnesota specializing in soilborne diseases of soybean.

> "WE CAN NEVER ELIMINATE THE DAMAGE, BUT WE CAN PROVIDE TOOLS TO REDUCE LOSSES THE DISEASES CAUSE."
>
> **— JAMES KURLE**

Each year the U.S. soybean crop is attacked by a complex of oomycete (water molds) and fungal pathogens that interfere with stand establishment and limit soybean production. Annual losses are estimated at $3.6 billion.

In the North Central region, the root pathogens the study focused on are the major culprits. Phytophthora stem and root rot caused by Phytophthora sojae has consistently ranked as the second most destructive soybean disease during the past decade.

Diseases caused by the pathogens being studied are not effectively controlled by crop rotation and seed treatments are important but provide limited help. Development of disease-resistant soybean cultivars, especially for early maturing soybeans, is a critical part of an integrated management solution.

"We can never eliminate the damage, but we can provide tools to reduce losses the diseases cause," Kurle said.

> "IT'S A SITUATION THAT WILL ALWAYS CONFRONT US. THE PATHOGENS WILL CHANGE AND ADAPT TO NEW RESISTANCE RESOURCES AND FUNGICIDES. WE'RE TRYING TO STAY AHEAD OF THE PATHOGEN."
>
> **— JAMES KURLE**

Phytophthora seedling, root and stem rots have been managed by race-specific resistance. To date, 17 Phytophthora sojae resistance (Rps) genes conferring race-specific resistance have been identified and several are already used in many cultivars. However, repeated use of a single Rps gene spurs resistance. Researchers in North Central states found Phytophthora sojae pathotypes increasing in number and complexity.

"It's a situation that will always confront us," Kurle said. "The pathogens will change and adapt to new resistance resources and fungicides. We're trying to stay ahead of the pathogen."

Purdue University collaborated on the project. It provided genes with resistance to Phytophthora sojae available in late maturing soybeans that are now being incorporated into early maturity groups.

The new sources of resistance are being tested and incorporated into breeding material, Kurle said. Optimistically, he hopes new resistant seed varieties will be available to farmers in six to eight years.

The team identified QTLs underlying resistances to these soilborne pathogens and worked to develop molecular markers that can be used to assist breeders to introduce new resistence genes.

Staying ahead of the pathogen is crucial to continued growth in soybean productivity for years to come.

CELEBRATING 25 YEARS

Farmers, researchers and state staff from all across the North Central region gathered in St. Louis to celebrate 25 years of collaborating together to improve farmer profitability through the North Central Soybean Research Program (NCSRP).

"It seems like just yesterday that we formed NCSRP," said Dave Schmidt, NCSRP's first president and farmer from Iowa City, Iowa. "The states weren't talking to each other about research, researchers weren't talking to each other about projects and that's how NCSRP came about. A common goal and a passion for basic research."

NCSRP is a farmer-led organization that invests soybean checkoff dollars in regional research. Twelve state soybean boards actively participate and fund NCSRP including Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota and Wisconsin. The group meets three times a year to discuss research proposals, the progress of current projects, common issues among the states and the direction of future research.

Over the last 25 years the board has funded more than 45 million dollars in soybean research. An investment researchers around the region have noticed.

"Thank you," said Anne Dorrance, Ph.D., professor at The Ohio State University. "On behalf of the university researchers across the north central region we can't thank you enough for everything you've done. Thank you for your support all these years, without it we would not have been able to double soybean yields in the last 20 years."

The 12 NCSRP member states grow nearly 85 percent of the soybeans produced in the United States and represent more than 350,000 farmers. The farmers representing these states on the NCSRP board have a shared vision and commitment to regionally coordinated research and communication efforts. From pest management to farmer communication, the group has had a major impact on the soybean industry at the state, regional and national level.

While it may have had a historical impact on the soybean industry, the directors of NCSRP don't plan to rest on past accomplishments.

"It's pretty amazing what this organization has accomplished in its 25 years of existence," said Gene Stoel, NCSRP's current president and farmer from Lake Wilson, Minnesota. "We have to celebrate our successes. Just getting a group of people like this together will bring us more ideas of what we need to do next. We know what we need to get done and we know what we need to research."

Twenty-five years of innovation and collaboration for the betterment of soybean farmers: with the support of all 12 states, the next 25 are going to be even better.

Probably my greatest satisfaction is how the NCSRP concept was successful in bringing university researchers and industry representatives together to jointly address soybean production concerns. The NCSRP Board can be proud of its accomplishments over the past 25 years. I am glad I was allowed to be a part of this program.
— Dr. Keith Smith

"IT'S PRETTY AMAZING WHAT THIS ORGANIZATION HAS ACCOMPLISHED IN ITS 25 YEARS OF EXISTENCE."
— GENE STOEL

HOW WE COMMUNICATE.

A FARMER'S BEST ONLINE TOOL FOR ONGOING INITIATIVES.

More soybean farmers are getting an edge on other grain farmers at the North Central Soybean Research Program's SRII website, **SoybeanResearchInfo.com**. This checkoff funded informative website provides links to informative web, print, video resources and highlights of the most current research about soybean pests, diseases and agronomics.

The Soybean Resource Library is filled with the most recent publications, field guides, videos and webinars on soybean production in the North-Central region with topics including fungicide, seed treatment efficacy, preemergent herbicides and many more.

For farmers wanting to find out more about research projects being conducted, simpy visit the National Soybean Checkoff Research Database website, **SoybeanResearchData.com**. Here farmers can discover the ongoing news and expert information for each project, the deliverables and progress of the research and most importantly, the research results and how it is helping soybean farmers in different regions of the country. It's all the information farmers need to stay informed, equipped and ultimately, more productive in soybean farming.

MORE THAN **276**

RESOURCES AND PUBLICATIONS AVAILABLE ON THE SRII WEBSITE.

TOP **5** RESEARCH HIGHLIGHTS PAGEVIEWS

1. Major Findings on Soybean Vein Necrosis Virus: Seed Transmission and Impact on Seed Quality - **9,346**
2. Developing an Integrated Management Plan for Soybean Sudden Death Syndrome (SDS) - **9,282**
3. Exploiting Bio-Control Agents to Manage Seedling Diseases of Soybean - **8,539**
4. New Reference Guide Helps Producers Assess If and When to Use Neonicotinoid Seed Treatments - **7,628**
5. Seedling Diseases of Soybean: Characterization and Education - **4,552**

SOYBEAN *Research & Information* INITIATIVE

NATIONAL SOYBEAN CHECKOFF RESEARCH DATABASE

BRINGING RESEARCH TO THE FIELD

Getting research results into farmers' hands isn't easy, but the North Central Soybean Research Program (NCSRP) is working with regional researchers to update farmers on the latest information to improve productivity and profitability.

The NCSRP project "Soybean extension Group: Bringing Science to Farmers" is working to bridge the gap between research and Extension to provide farmers and stakeholders alike the most up-to-date information regarding integrated soybean management.

According to project lead Kiersten Wise, Ph.D., soybean farmers in the North Central region directly benefit from current and timely extension material. Such publications aid in the identification and management of emerging diseases and other agronomic and pest issues.

"This project strengthens the communication between university scientists and NCSRP," said Wise, formerly at Purdue University and now associate professor at the University of Kentucky. "It allows farmers access to the most current information available on soybean management."

Formerly the North Central Disease Study Group, the extension group has expanded from only plant pathologists to include agronomists and entomologists, with the goal of diversifying the information provided to soybean farmers about production issues.

"Our past model was to identify soybean disease issues of emerging importance, hot topics and research updates, and to create electronically available bulletins, scouting cards, video resources and more for distribution through extension channels," said Wise.

The publications and videos are available on sites such as the Crop Protection Network (CPN), and the main online resource for NCSRP research information, the Soybean Research and Information Initiative (SRII) website: soybeanresearchinfo.com.

To date, the group has produced 15 publications each in multiple formats to better serve farmers. The different publication formats include a full-length research summary, a one-page factsheet and a scouting card for farmers to use while in the field. The publications have been printed or downloaded more than 90,000 times from SRII, CPN, Purdue Extension websites, and the Iowa State Education Store, as well as being distributed to stakeholders across the North Central region as well as Alabama, Tennessee, Mississippi and Canada through Purdue University.

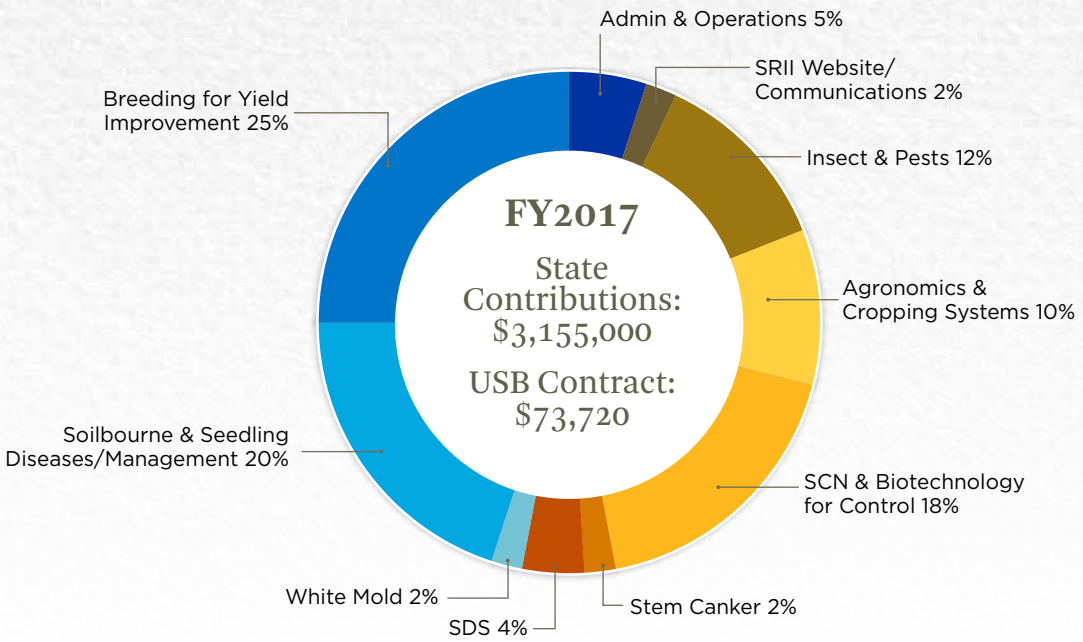
In addition to having an impact on farmer productivity, the publications are part of the basic agronomy course for DuPont Pioneer seed dealers. This means the publications are getting into the hands of approximately 300 seed dealers every year.

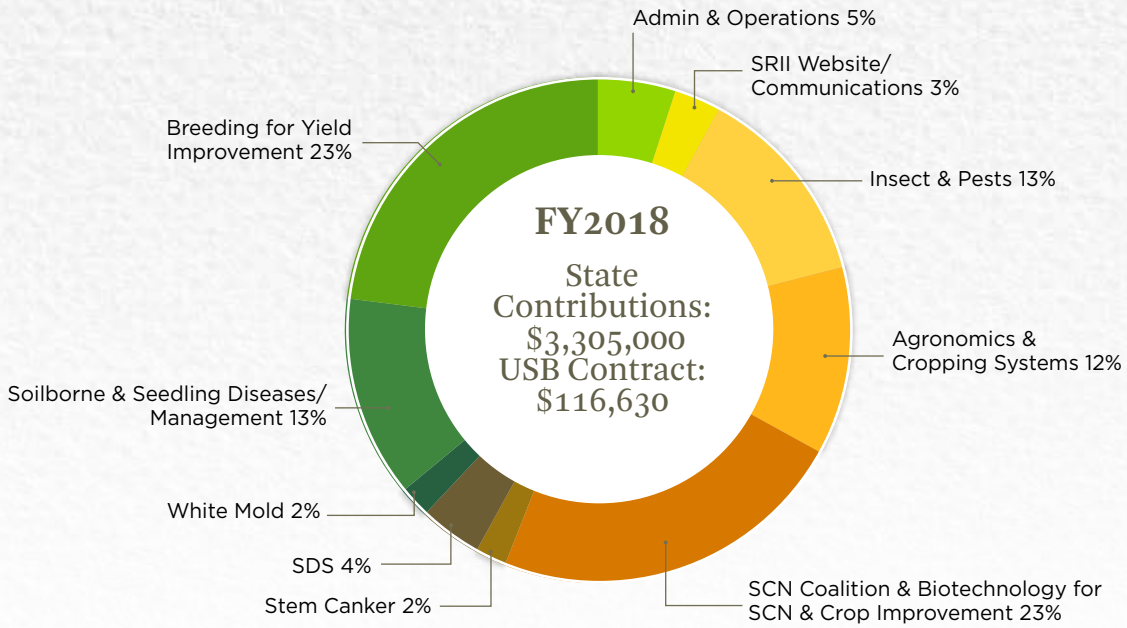
Over the past year the group created two new publications: Frogeye Leaf Spot and Fungicide Resistance in Field Crops FAQs. More than 27,000 print versions of these publications were distributed to the North Central states through Purdue University and are available in the SRII Resource Library.

The Frogeye Leaf Spot factsheet offers strategies to manage the disease and the potential impact and yield losses of not treating it. The publication outlines the symptoms and signs farmers should look for when scouting, including images depicting different stages of the disease's progression and pictures to help distinguish frogeye leaf spot from other diseases that may have similar visual symptoms. The factsheet also outlines the environmental conditions that are most favorable for disease development.

The Fungicide Resistance in Field Crops FAQs publication answers a series of questions heard from farmers about combatting fungicide resistance. The booklet includes a table developed by the Fungicide Resistance Action Committee (FRAC) to help farmers classify fungicide resistance. The table contains a numeric code with each number representing a specific target or fungicide group name and resistance potential. When farmers buy fungicides, the labels include these FRAC codes. If a fungus is resistant to a specific fungicide active ingredient, it may be resistant to all the active ingredients with the same FRAC code. Knowing this information is crucial for farmers dealing with disease pressure.

The Scouting for White Mold publication was updated during 2017 to include new fungicide application recommendations for white mold management and is currently available on the CPN website.





NCSRP NORTH CENTRAL SOYBEAN RESEARCH PROGRAM

Illinois Soybean Association | Indiana Soybean Alliance | Iowa Soybean Association | Kansas Soybean Commission | Michigan Soybean Promotion Committee | Minnesota Soybean | Missouri Soybeans | Nebraska Soybean Checkoff | North Dakota Soybean Council | South Dakota Soybean Research & Promotion Council | Ohio Soybean Council | Wisconsin Soybean Marketing Board

North Central Soybean Research Program
1255 SW Prairie Trail Pkwy | Ankeny, IA 50023 | www.ncsrp.com

Funded by the soybean checkoff.