**2018 Annual Report: NCERA 137**

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**State(s):** Alabama, Arkansas, Delaware, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Ohio, Maryland, Minnesota, Missouri, New York, North Carolina, North Dakota, South Dakota, Tennessee, Wisconsin

**Date:**  May 1, 2019

**Project Title:** Soybean Diseases

**Objective 1:** Foster collaborative research and information exchange on new and emerging soybean diseases among scientists in the North Central Region including soybean breeders and entomologists that will lead to improved disease screening protocols, additional sources of disease resistance genes and ultimately, improved host plant resistance.

Alabama: Collaborating with plant pathologists and plant breeders in the mid-south region to develop soybeans lines resistant to Cercospora leaf blight. We conduct one variety trial in Alabama annually as part of the program. Continue collection of isolates of *Xylaria* spp, causal agent of tap root decline to help determine distribution of the disease and genetic variability in populations in the southeast.

Illinois: Obtained competitive institutional funding for researching methodologies that enable rapid quantification of *Phytophthora sojae* races from plant and soil samples without the need for laborious differential screening. Collaborated with Doris Lagos Kuntz and Nicholas Seiter to conduct studies assessing the impacts of thrips arrival on SVNV and plant response under controlled conditions. Conducted studies comparing the effectiveness of Pythium and Phytophthora detection protocols relative to time in storage to aid diagnostic clinics in selecting the appropriate screening methods.

Iowa: The Crop Protection Network (CPN) is a multi-state and international collaboration of university/provincial extension specialists and public/private professionals who provide unbiased, research-based information to farmers and agricultural personnel. In 2018, the CPN launched an updated CPN websitewith a disease encyclopedia with advanced search capabilities, video content, and other features; begin work on a collaborative new edition of Fungicide Use in Field Crops; and published four soybean-related publications including Considerations for Selecting Soybean Varieties, Factors to Consider Before Using a Soybean Seed Treatment, Fungicide Efficacy for Control of Soybean Seedling Diseases, and Fungicide Efficacy for Control of Soybean Foliar Diseases. Nearly 36,000 PDF downloads of all CPN publications occurred in 2018. The CPN furthered work on an online tool for training researchers and field scouts on foliar disease severity estimates for soybean diseases as well as a tool to allow queries for yield and economic loss estimates due to soybean diseases across multiple parameters including year, state, region, and disease type. The CPN continues to provide a venue and a method of collaborative publication development among research and extension personnel involved with soybean disease in the North Central Region.

Kansas: One hundred and eighty-nine advanced breeding lines were screened for SCN HG Type 7 resistance. Forty-four percent of early maturity lines and 54% of late maturity lines were characterized as resistant or moderately resistant. Fourteen percent and 48% of 111 Soybean Variety Performance Test entries were resistant or moderately resistant, respectively, to the HG Type 7 population, while only 1% and 16% of entries were resistant or moderately resistant, respectively, to the HG Type 2 populations.

Louisiana: We continued to collaborate and exchange information with pathologists, breeders, and entomologists across the U.S. developing varieties resistant to Cercospora leaf blight, stink bugs, and other important soybean pests. We have identified commercial varieties and plant introductions with resistance across locations and years. Drs. Sara Thomas-Sharma and Brian Ward (LSU) continued to develop a rapid screening protocol for Cercospora leaf blight based on leaf disk reaction to cercosporin. Dr. Ward amassed a collection of ~1,000 *Cercospora* spp. isolates from soybean during the 2018 growing season for characterization, fungicide resistance analysis, and other future studies. Our collaboration with southern colleagues on taproot decline, an emerging and significant threat, continued with group efforts on identifying sources of resistance for the disease.

Minnesota:

* J. Kurle and D. Malvick are participating in a collaborative research project on *Phytophthora* pathogens affecting soybean across the North Central U.S., with the goal of improving durability of resistance in soybean.
* D. Malvick is conducting studies on improvement of evaluation protocols and has been working to identify tolerance or partial resistance to Rhizoctonia root rot.
* D. Malvick is working on improving screening protocols for resistance to brown stem rot.

North Carolina: Screened 300 soybean varieties for potential cross-resistance for the management of *Meloidogyne enterolobii*.

Ohio:

* Mapped and characterized numerous loci for resistance to *Phyophthora sojae, Pythium ultimum var ultimum, Pythium ultimum var sporangiferum, Pythium irregulare* and *Fusarium graminearum*.
* Evaluated the components of partial resistance to *Sclerotinia sclerotiorum*, identified that different components are involved in the expression of resistance. Accurate characterization and combination of all components is necessary for the highest levels of resistance.
* Evaluated the population diversity of *Pythium irregulare* isolates collected in Ohio. The population is a complex and among these isolates collected in Ohio, there were two groups represented along with *Pythium cryptoirregulare*. All were pathogenic on soybean.
* An improved apple latent spherical virus gene silencing construct was used to silence genes in soybean. This virus can infect and silence genes in specific cultivars and more importantly in the pod and seed. This will be an effective tool especially in more unadapted germplasm.

South Dakota: Research was undertaken to compare inoculation methods to study the aggressiveness of isolates of *D. caulivora*, *D. longicolla* and *D. aspalathi* from multiple states (KY, IN, IA, SD and MI). A publication on this work was accepted by Plant Disease.

Wisconsin: The Smith laboratory maintains a small soybean breeding program with the goal to improve resistance to white mold in northern soybean varieties. We have made significant progress over recent years and will be releasing our first variety W16-9138 (Dane) as a public, non-GMO, food grade variety in 2019.

**Objective 2:** Compare findings on the impacts of changing production practices such as earlier planting dates, new sources of host plant resistance, increased use of fungicide seed treatements and foliar fungicides, and other new or improved crop production technologies on soybean diseases that could be adopted for other production areas in the region.

Alabama: We continue to conduct fungicide trials focused on soybean rust, frogeye leaf spot, Cercospora leaf blight and target spot in various locations in the state. Product’s evaluated consists of both labeled and numbered compounds. This type of research is important particularly due to the lack of sufficient information on fungicide efficacy for target spot as well as for the limited locations in the U.S. that can provide adequate data on soybean rust control.

Arkansas: Six field trials were conducted to evaluate host plant resistance to southern root knot nematode and two trials to evaluate new seed-applied nematicide.

Illinois: Collaborated on an NCSRP project assessing the impacts of different soybean seed treatments and varieties on SCN and SDS. Coordinated multi-state trials assessing the effects of fungicide timing and row spacing on soybean yield, green stem, and disease in double crop systems.

Indiana: Evaluation of fungicide seed treatment and fungicide foliar applications in Indiana.

* One seed treatment trial, 5 products, inoculated with Rhizoctonia
* Five foliar fungicides trials, with 9-12 products – frogeye, Cercospora leaf blight, SDS, main disease issues.

Iowa: The effect of fungicide and crop protection products on severity of sudden death syndrome (SDS), plant establishment, and soybean yield has been evaluated in field experiments in Illinois, Indiana, Iowa, Michigan, South Dakota, Wisconsin, and Ontario, Canada since 2013. Susceptible and moderately resistant soybean cultivars were planted in fields with a history of SDS and/or with artificial inoculation with the SDS pathogen. Efficacy of seed, in-furrow, and foliar-applied fungicides was assessed. SDS levels varied across locations and years. Foliar symptoms of SDS were significantly reduced using ILeVO®(fluopyram, Bayer CropScience) as a seed treatment or applied in-furrow. Moderately resistant cultivars had less disease than susceptible cultivars indicating that resistant cultivars in combination with effective seed treatment could provide effective management of SDS. Field and greenhouse studies were conducted on the impact of cover crops on soybean diseases. Field trials were established in eight locations in Iowa and one location in Ontario, Canada, to evaluate the effect of rye and/or oat cover crops on SDS (4 locations), white mold (2 locations) and iron deficiency chlorosis (2 locations). Two soybean varieties were included in each trial and a no-cover crop treatment was used as a control. Cover crops were planted either as a fall cover or a spring companion crop, depending on the location. Assessments were made for plant stand, disease severity and incidence, and soybean yield. Across the different locations, we found that the cover crop treatments did not have a significant effect on disease, plant stand or soybean yield. The results from the first year of this study suggest that growers can use rye and oat cover crops without  a detrimental effect of soybean health and productivity.

Kansas: It was demonstrated that SDS frequency significantly decreased with increasing levels of phosphorus application. *Brassica juncea* cv. ‘Mighty Mustard Pacific Gold’ planted as a pre-season cover crop and then incorporated into the soil, reduced the colonization and severity of *Macrophomina phaseolina* compared to the untreated control.

Kentucky: Led a “uniform fungicide trial” conducted across multiple states with the objective of determining which foliar fungicides have the best efficacy for management of frogeye leaf spot of soybean. Conducted a multi-site nematicide seed treatment trial in Kentucky in collaboration with the University of Kentucky Soybean Variety Testing Program. Initiated a research trial at two Kentucky locations to determine the effect of fungicides on southern stem canker of soybean.

Louisiana: Use of fungicides in soybean has decreased in recent years. This is attributable to the discovery of fungicide resistance in multiple soybean pathogens. Field trials over the past two years in Louisiana indicated that newly-released SDHI compounds and triazoles have somewhat consistent activity on Cercospora leaf blight. Adoption of minimum to no-tillage practices along with limited crop rotation options (due to low commodity prices) has led to an increase in taproot decline, a largely debris borne disease, since 2014.

Minnesota: D. Malvick is developing and refining information on the use of foliar fungicides for management of white mold, and continues to contribute to studies of SDS management with seed treatment fungicides and partial resistance. Results from studies conducted in Minnesota have been used in regional publications.

Missouri: Strip trials comparing the application of a fungicide vs no fungicide application were conducted at ten locations throughout the state of Missouri. This paired comparison did not specify a product to use but was intended to test the impacts of using a fungicide for disease control in soybeans. Small plot studies included 3 foliar fungicide efficacy trials and 1 trial comparing SCN seed treatment efficacy.

North Carolina: Nematicide seed treatments (n=12) were assessed for control of root knot nematode, soybean cyst nematode, and lesion nematodes.

North Dakota: Approximately two dozen field trials were run to provide growers better information on managing SCN, white mold, root rots and downy mildew.

Ohio: Several seed treatments were evaluated at 5 locations, foliar fungicides at 2 locations, and fungicides for efficacy of white mold in 2 locations in Ohio during 2018.

Tennessee: Screened ~105 commercial varieties (maturity groups 3, 4, and 5) at 2 to 3 trial locations in split plot design with fungicide treatment at growth stage R3 – data available to public at search.utcrops.com.

Wisconsin: The Smith laboratory is leading a multistate, multisite field experiment to understand the integrated management of white mold on soybean. Trials are being evaluated in numerous north central states to build improved management recommendations for the disease.

**Objective 3:** Compare data from studies of the ecology and epidemiology of soybean diseases important in the North Central Region.

Alabama: Share data and isolates with researchers at the University of Wisconsin to study the occurrence and epidemiology of *Soybean vein necrosis* *virus and Tobacco streak virus* in Alabama in order to compare and contrast the situation in the southeast with that occurring in the north-central region.

Kentucky: Working collaboratively with the Esker lab (Penn State Univ.) and the Allen lab (Mississippi State Univ.) to determine long-term soybean disease trends in the U.S. using the soybean disease loss estimate database that was initiated in 1996.

Tennessee: Utilized statewide soybean sentinel plots to monitor major foliar diseases throughout the 2018 season.

Wisconsin: Weather-based models for assessing the risk of *Sclerotinia sclerotiorum* apothecial presence in soybean fields were developed from multi-state trials. A Smartphone application called Sporecaster was developed to deliver the models to farmers across the U.S. and Canada. Sporecaster was made available to the public as a free download on the Google Play Store and iPhone app store in May of 2018. Sporecaster was validated at all research locations. As of this report, Sporecaster was downloaded over 1,600 times from the Apple and Android stores. Daily use rates during the major “white mold season” (July and August) averaged 250 users per day. As previously mentioned, we also added commercial field validations to this objective. In those validations of 16 commercial fields, Sporecaster was accurate about 80% of the time in predicting yield limiting disease events. Currently, programming adjustments are being made to Sporecaster in preparation for the 2019 field season.

**Objective 4:** Improve knowledge transfer about soybean diseases and their management in the North Central Region to researchers, Extension faculty, producers and the agribusiness community through the use of web sites, podcasts, social media (Twitter and Facebook) and other new technologies as they are developed.

Delaware/Maryland: End of season disease information was disseminated to stakeholders through face-to-face meetings, Mid-Atlantic Crop School, training meetings, and twitter.

Indiana:

* Student (high school) crop scouting contest– soybean disease ID
* 13 speaking events (field days, pesticide training, conferences) reaching over 1200 producers and agribusiness community
* One article about fungal diseases in soybean written for Purdue Pest&Crop newsletter - *Pest and Crop Newsletter* published by Purdue IPM is emailed to 3596 subscribers and reached over 164,000 unique views. By online evaluation, 99% indicated that the Pest&Crop newsletter was timely, 97% confirmed their pest identification through visual aides from this publication, and 88% applied information to their pest treatment decisions. Two thirds indicated this newsletter increased their profitability and 64% said the Pest&Crop is their main source of pest information
* Social media – 547 followers

Kansas: Knowledge and information were disseminated in several formats. The K-State Crop Diseases Facebook page has 1,157 followers. Twenty-four soybean disease specific posts were made in 2018. The average reach per post was 598 and the average engagement per post was 42. Each post was shared an average of two times. The @ksu\_cropdoc Twitter page has 1,417 followers. Twelve and 108 soybean disease specific tweets and retweets were made in 2018. Four soybean disease specific articles were published in the *eUpdate* newsletter, which has 7,300 subscribers.

Kentucky: In collaboration with the Mueller lab (Iowa State University), we published an article in *Plant Disease* about using social media (Twitter) to track soybean and corn diseases. Disseminated soybean disease management information to stakeholders across the U.S. with Crop Protection Network (CPN) articles, the Take Action against fungicide resistance program, and the Soybean Cyst Nematode Coalition. These are all national programs that promote collaboration across several members of the NCERA 137 and uses their expertise to reach a wide range of clientele.

Louisiana: Results from our numerous research projects have been extended to all stakeholders via a variety of methods including: face-to-face visits, phone communications, text blasts, web blogs, newsletters, grower meetings, professional meetings, and other venues.

Minnesota: D. Malvick has contributed to knowledge transfer about soybean diseases and their management via contributions to publications on the Crop Protection Network and via web sites.

Missouri:

* Execution of 5 scouting schools focusing on disease scouting basics, common diseases affecting soybean production, and fungicide resistance management
* Development of MU Extension Field crop plant pathology website
* Regular Twitter updates regarding disease presence and severity in season
* Participated in the development of 2 SCN-focused podcasts (All in a Row)

New York: Continue to add content to Cornell Diseases of Soybean Webpage (https://fieldcrops.cals.cornell.edu/soybeans/diseases-soybeans/ ) Presentations made on soybean diseases to these audiences by Gary Bergstrom in 2018:

* Field Crop Dealer Meeting/ Northeast Region Certified Crop Advisor Training School, Syracuse, NY. Workshop on Soybean Cyst Nematode and other Nematodes in the Northeast (presentations by George Bird, . (11/29/18)
* Finger Lakes Soybean and Small Grains Congress, Waterloo, NY. (2/8/18)
* Western New York Soybean and Small Grains Congress, Batavia, NY. (2/7/18)
* North Country Crop Congress, Lowville, NY (2/1/18)
* Miner Institute Crop Congress, Chazy, NY. (1/31/18)

North Carolina: Improved understanding of disease management by engaging with stakeholders at production meetings and field days for over 680 contact hours. Engaged with stakeholders through social media platforms (over 450 followers) and websites (52,853 page views) to present emerging soybean disease information.

North Dakota: In 2018/19, the Soybean Cyst Nematode (SCN) Coalition was launched and is not one of the largest Extension programs in plant pathology. The SCN Coalition, a coalition of Private Corporate partners, Checkoff organizations and University partners, was launched in February 2018. Multi-layer knowledge transfer is a cornerstone of the anticipated outputs, which have been designed to allow/encourage producers to change the way they manage SCN (a true change of practice). International (US and Canada). Succinctly, outputs include 1) an online resource center (website) with state/company specific embedded pages testimonial videos, training videos and materials, 2) a national launch at the 2018 Commodity Classic, 3) a presence at 2018 Farm Progress (Iowa), 4) a media push for fall sampling in 2018, 5) a 32-page SCN insert into the December issue of the Corn+Soybean Digest (113,000 readers), and 6) another presence at Commodity Classic 2019. Each of these has significant media presence

Ohio: Continued to write articles for the Ohio State Agronomy Team Crop Observation Recommendation Network Newsletter with timely scouting and management information for soybean diseases.

South Dakota: A webinar on “Diagnosing disease caused by *Diaporthe*/*Phomopsis* complex on soybean” was done for the North Central Region through the Great Plains Diagnostic Network in 2018 (Link - http://msuextensionconnect.org/p11lr20oicz6/)

Tennessee: Multiple newsletter/blog articles posted on news.utcrops.com and disease identification and management resources highlighted at guide.utcrops.com. Hands on training at annual soybean disease field day held at Milan Research and Education Center and multiple in-season soybean scout schools held in farmers’ fields in July.

Wisconsin: Wisconsin researchers continue to deliver high-quality research-based information to farmers and practitioners in a variety of ways. Coolbean.info and the Wisconsin Field Crops Pathology website (badgercropdoc.com) are the primary methods of delivery. However, Both Dr. Conley (@badgerbean) and Dr. Smith (@badgercropdoc) maintain active twitter accounts and push all new information in this platform.

**Objective 5:** Continue to monitor and share information for any new or reemerging pathogens of soybean in the North Central Region and develop appropriate responses to their emergence as they occur.

Alabama: Sharing observations, isolates and data with researchers at LSU and Mississippi State University on *Xylaria* spp., cause of taproot decline, as we continue to learn about this emerging disease of soybeans in the U.S.

Delaware/Maryland: Plants with symptoms resembling brown stem rot were submitted to the UD diagnostic clinic towards the end of the season. This will be scouted for next season to molecularly confirm diagnosis since this has not been reported in Delaware.

Kentucky: Continue to monitor for QoI fungicide resistant strains of *Cercospora sojina* and *Septoria glycines* across the U.S.

Louisiana: We have alerted “northern” pathologists of taproot decline and expect that the disease will be discovered in other states; particularly in southern Missouri, Illinois, and Kentucky.

Minnesota: D. Malvick has begun monitoring the occurrence and distribution of frogeye leaf spot in Minnesota, which is a new disease for the state. He is also working with colleagues in North Dakota on the distribution and spread of sudden death syndrome and brown stem rot into areas where it has not been found.

Missouri:

* Monitoring for Taproot decline in the southern portion of the state (Bootheel in particular)
* Began surveying for fungicide resistant *Cercospora sojina* to document distribution

North Carolina: Survey of *Meloidogyne enterolobii* distribution in North Carolina (present in 8 counties) and continued monitoring of reports in other regions (found in FL, SC, NC, MS, and LA).

Ohio:

* Fungicide resistance monitoring for QoI resistance was done for *Cercospora sojina* for the G143A mutation at 10 locations. Surprisingly there were still isolates that were sensitive.
* Scouted and identified southern stem canker occurrence in Ohio during 2018. Much less than outbreaks in 2017.

South Dakota: *Diaporthe gulyae* was identified causing pod blight of soybean in South Dakota. *Phytopthothora sansomeana* was detected for the first time in soybeans. Resistance to QoI was detected in *Cercospora sojina* in South Dakota.

Tennessee: Documented the second report of taproot decline in Tennessee (first report from Hardeman County in 2017) in research plots at Milan Research and Education Center in Gibson County and at on-farm location in Madison County in 2018. Confirmed by morphology and molecular identification. Soil survey campaign – screening for pathogenic nematodes and charcoal rot pathogen.

Wisconsin: We are leading a new research project to investigate the interaction of *Soybean vein necrosis virus* (SVNV) and *Tobacco streak virus* (TSV) in soybean, and the impact that this interaction has on seed health. Our research lab has previously worked on describing seed transmission of SVNV and partnered with Iowa State University researchers to show evidence that SVNV and TSV co-occur naturally in soybeans.

**Impact statements:**

Alabama: We continue to monitor statewide for soybean rust (SBR) other diseases via the soybean sentinel plot system accompanied with biweekly monitoring of SBR-susceptible kudzu patches in Alabama. When soybean rust is detected in a county or region, a disease alert goes out to regional extension agents and directly to growers to help them prepare for the disease. SBR can be a significant problem in Alabama, though in 2018 the disease was only found in 12 of the 67 counties due to significant periods of freezing.

Arkansas: Main impact in soybean is raising awareness of importance of fungicide-resistance management strategies and susceptibility of commercially available soybean varieties to southern root-knot nematode.

Delaware/Maryland: Outreach and extension presentations were given to discuss end of season disease pressure and assess needs for establishment of 2019 research projects. A grant from the Delaware Soybean Board for a 2019 survey of soilborne fungal and nematode pressure across DE and MD was funded.

Indiana: Since starting at Purdue in August 2018, the field crops pathology Extension program in Indiana has provided up-to-date information on field crop diseases and their management. 17 Extension presentations to over 1,200 people in 2018. These included Diagnostic Training Center (DTC) events that addressed 90 participants about field crop diseases. Participants highly rated the educational value of the workshops as indicated by survey results: 98% of the participants indicated that the workshops clearly helped them improve their overall crop production knowledge; 93% of the participants (when considering their costs) indicated that attending these workshops was well worth their time and expense; and 98% of the participants determined that the information gained will likely be shared with colleagues/customers. Awareness about SCN and management was also included during 7 presentations in 2018, reaching 497 individuals.

Iowa: Main impact in soybean is raising awareness of importance of fungicide-resistance management strategies and how to think about poor seed quality for 2019 season.

New information showing that the use of rye cover cropping is not detrimental to soybean health or productivity.

Kansas: Weekly scouting of soybean fields across the state allowed for the discovery of significant levels of frogeye leafspot and late-season Phytophthora root rot over large portions of north central and northeast Kansas. As a result of the monitoring efforts, spray advisories for frogeye leaf spot were issued. A review of Phytophthora root rot management has been ongoing at producer and consultant meetings since fall of 2018, including the role of race-specific genes vs field tolerance in management of the disease.

Kentucky: A major focus of my program in 2018 was educating growers and the soybean industry about fungicide resistance and management of frogeye leaf spot. As part of this, I work closely with the “Take Action on Fungicide Resistance Team” in developing educational material and content that is used to promote awareness of fungicide resistance and provide recommendations used to manage fungicide resistance.

Louisiana: Seed treatment and foliar fungicide efficacy trials were conducted at multiple research stations in Louisiana. These trials generate information that forms the basis of fungicide recommendations to producers. Other long-term trials examining the effect of cultural practices (rotation, tillage) on soybean diseases also were continued. Renewed interest in cover crops has resulted in the installation of long-term cover crop trials, mainly geared towards their effect on seedling disease pressure. Official variety trials (OVT) were monitored for foliar diseases throughout the state, rated, and results posted on the web. In northeast Louisiana OVTs were rated at harvest for seed quality, which has become a very important issue in recent years. Some varieties weather better than others, and this information has been distributed to stakeholders. Soybean variety development efforts continued in cooperation with breeders and pathologists in the mid-south. Many on-farm demonstrations and research trials were conducted in the state during 2018. Of note, we continued efforts in southwest Louisiana where strobilurin-resistant Rhizoctonia aerial blight has been discovered. SDHI compounds appear to remain effective on the pathogen; however, there have been some unconfirmed reports of failures in rice. To date, we have fungicide resistance in the aerial blight, Cercospora leaf blight, and frogeye leaf spot pathogen populations. We highly suspect resistance in the pathogens that cause brown spot and target spot. Diseases/pathogens of note that occurred in Louisiana soybean and that caused significant losses during 2018 included: aerial blight, anthracnose, Cercospora leaf blight, charcoal rot, frogeye leaf spot, pod and stem blight, reniform nematode, Septoria brown spot, southern RKN, taproot decline, and target spot. Well-over 200,000 acres (out of 1.2 million) of soybean were not harvested because of horrible weather conditions at harvest. Yield potential was above average for the season.

Minnesota: D. Malvick has conducted studies of SDS management with seed treatment fungicides and partial resistance to improve and optimize management of this disease. Multiple studies were conducted in two locations in Minnesota over several years, and the results from these studies have been used in extension education programs, agriculture conferences, and scientific publications. He has also conducted studies on white mold management in soybean over multiple years, and the results from this work has positively impacted white mold management.

Missouri: The main impacts of this program were an increase in soybean disease management literacy and a rise in awareness about fungicide resistance and its management amongst agricultural professionals in Missouri.

New York: Through disease survey, diagnostic services, and extension program we have advised soybean growers in New York of the most important diseases which merit their attention and potential management.

North Dakota: SCN is widely considered the most economically important soybean disease in the United States. The SCN Coalition is one of the largest extension programs on field crops in the United States. The SCN coalition is made up of Private partners, Checkoff organizations and University partners, and was launched in February 2018. Approximately 30 scientists are involved in the SCN Coalition, several co-lead the coalition and North Dakota State University is the lead institution. Multi-layer knowledge transfer is a cornerstone of the anticipated outputs, which have been designed to allow/encourage producers to change the way they manage SCN (a true change of practice). International (US and Canada). Succinctly, outputs include 1) an online resource center (website) with 2) state/company specific embedded pages, 3) testimonial videos, 4) training videos and 5) downloadable materials, 6) a national launch at the 2018 Commodity Classic, 7) followup events including Farm Progress and Commodity Classic 2019, and 8) a 32-page insert into the Corn+Soybean Digest (December issue).

Ohio: Continued to provide soybean breeding industry support in characterization of sources of resistance as well as isolates used for screening and development of cultivars for the U.S. Provided diagnostic information for emerging problems in Ohio. Provided updated management recommendations on the efficacy of seed treatments and fungicides for foliar diseases and Sclerotinia stem rot.

South Dakota: Outreach and extension activities were carried out to inform growers, crop consultants and agronomists on soybean diseases and their management (see below extension publications). Awareness and free SCN testing was offered for growers in South Dakota. A grant was secured from the South Dakota Soybean Research and Promotion Council to pay for the SCN testing.

Tennessee: Significant activities in 2018 include meeting and developing strong relationships with county agents, Tennessee farmers, extension and research colleagues, consultants, industry and other agricultural professionals, as well as posting news articles on the utcrops.com blog, popular press articles, research articles, and participating in in-service and county meetings - providing disease identification and management information. Specifically, in 2018 soybeans were harvested on more than 1.67 million acres in Tennessee in 2018. Excess rainfall in the spring and fall delayed planting and harvest resulting in lower yields and seed quality issues due to delayed harvest. Final state average yield was 48 bushels/acre (Jan 2018 NASS quick facts). Soybean prices were mediocre, due to tariff issues and weak exports; and most producers received close to $8.60 per bushel for their crop factoring in the tariff support payments from the government. Projected cash receipts for soybeans in 2018 are down from the previous year at 689 million dollars.

Wisconsin: Weather-based models for assessing the risk of *Sclerotinia sclerotiorum* apothecial presence in soybean fields were developed from multi-state trials. A Smartphone application called Sporecaster was developed to deliver the models to farmers across the U.S. and Canada. Sporecaster was made available to the public as a free download on the Google Play Store and iPhone app store in May of 2018. Sporecaster was validated at all research locations. As of this report, Sporecaster was downloaded over 1,600 times from the Apple and Android stores. Daily use rates during the major “white mold season” (July and August) averaged 250 users per day. As previously mentioned, we also added commercial field validations to this objective. In those validations of 16 commercial fields, Sporecaster was accurate about 80% of the time in predicting yield limiting disease events. Currently, programming adjustments are being made to Sporecaster in preparation for the 2019 field season.

**Publications (since last report)**

**Journal articles:**

Ajayi-Oyetunde, O. O., and Bradley, C. A. 2018. *Rhizoctonia solani*: taxonomy, population biology and management of Rhizoctonia seedling disease of soybean. Plant Pathology 67:3-17.

Akintayo, A., G. Tylka, A.K. Singh, A. Singh, B. Ganapathysubramanian, and S. Sarkar. 2018. A deep learning framework to discern and count microscopic nematode eggs. Scientific Reports 8:9145. DOI:10.1038/s41598-018-27272-w.

Beeman, A.Q. and G.L. Tylka. 2018. Assessing the effects of Ilevo and Votivo seed treatments on reproduction, hatching, motility, and root penetration of the soybean cyst nematode, *Heterodera glycines*. Plant Disease 102:107-113. dx.doi.org/10.1094/PDIS-04-17-0585-RE.

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Clifton, E.H., G.L. Tylka, A.J. Gassmann, and E.W. Hodgson. 2018. Effects of host-plant resistance and seed treatments on soybean aphid (*Aphis glycines* Matsumura),soybean cyst nematode (*Heterodera glycines* Ichinohe)*,* and soybean yield. Pest Management Science DOI: 10.1002/ps.4800.

Cruz, D. R., Ellis, M. L., Munkvold G. P. and L. F. S. Leandro. 2018. Isolate x cultivar interactions, in-vitro growth and fungicide sensitivity of *Fusarium oxysporum* Isolates Causing Seedling Disease on Soybean. Plant Disease 102:1928-1937 https://doi.org/10.1094/PDIS-03-17-0380-RE.

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