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| Project Number:  | 2020-172-0148 |
| Project Title:  | Enhanced Pest Control Systems for Mid-South Soybean Production |
| Organization:  | LSU AgCenter |
| Principal Investigator Name: | Paul P. Price, III (Trey) |
| **National Soybean Checkoff Research Database** [**https://www.soybeanresearchdata.com/**](https://www.soybeanresearchdata.com/) **(public website funded by USB). Please include a non-technical summary along with your project status. The non-technical summary will be published to the website. If a non-technical summary is not provided, the contents of this entire report will be published.** |
| Project Status - What key activities were undertaken and what were the key accomplishments during the life of this project? Please use this field to clearly and concisely report on project progress. The information included should reflect quantifiable results (expand upon the KPIs) that can be used to evaluate and measure project success. Technical reports, no longer than 4 pages, may be included in this section.  |
| We have completed the 5th growing season of this project and are awaiting data from cooperators. This season we were only able to conduct the public variety trial (PVT) as susceptible plant introduction (PI, n=25) seed had to be increased at University of Missouri. The PVT was conducted in the following states with the number of locations in parentheses: AR (3), AL (1), LA (4), MO (1), MS (2), TN (1), and TX (1). The majority of trials were completed successfully and had Cercospora leaf blight (CLB) and other disease pressures.Previous efforts regarding the evaluation of PIs reactions to CLB have been summarized and accepted with revision in the Journal of Crop Improvement. The take home message from this work is that we have developed an improved rating scale for CLB and identified over 50 PIs with resistance to Cercospora leaf blight. Since 50K SNP chip data is freely available for all of the PIs we have used over the course of the study, we plan to compare resistant and susceptible PIs in an attempt to identify QTLs for resistance during 2021. Four seasons of the PVT have been summarized and will be submitted for publication. The take home message from this work is that we have identified publicly available sources of resistance to CLB and other diseases. Plant samples from trials with CLB were sent to Drs. Brian Ward and Bishnu Shrestha (LSU) for pathogen isolations. We have amassed a collection of hundreds of *Cercospora* spp. isolates from seven states during 2018, 2019, and 2020. We are currently working on screening isolates for resistance to QoI fungicides. The populations also are being genetically characterized and compared geographically. These isolates are stored in multiple locations to ensure availability for future studies. During 2020, we had enough seed for six lines to be planted in five stink bug trials this year. Seed was shipped to cooperators on May 11, 2020. These are Dr. Shane Zhou at Texas A&M, Dr. Nick Bateman at University of Arkansas, Dr. Don Cook at Mississippi State, and Dr. Katelyn Kesheimer at Auburn. Stink bug numbers were high throughout the Midsouth and Southeast and data are being analyzed. Dr. Chen has successfully crossed his breeding lines with the stink bug resistant lines to create five populations that each had 150 plants; S14-9051R x TX12-1039, TX12-1034 x S11-20337GT, S13-3851C x TX12-1033, S15-16886C x TX12-1061, and S15-5904RY x TX12-1035. Twenty to 30 seed of each line was sent to Dr. Davis for evaluation. Dr. Chen planted these populations and evaluated for agronomic qualities this year, selecting the next set of lines for future stink bug evaluation.Dr. Chen’s group had 82 lines in 2020 advanced yield tests with resistant parental lines (S11-20242, S11-16653, and S13-10592) in the pedigree. These lines were tested in 5 Missouri locations each with 3 reps. They also have 606 lines in 2020 preliminary tests (2-4 locations with one rep) that have CLB resistant parental lines in the pedigree (S14-9017R, S15-3772RY, S11-20242, S14-9051R, S11-16653, S13-10592C and S14-15138R). In addition, 56 populations (~5000 progeny rows) were in our 2020 progeny row nursery that have CLB resistant parental lines from our 2018 crossing block. Dr. Chen made 19 successful crosses in 2019 with the following CLB resistant lines: S14-9017R, S15-3772RY, S11-20242. S11-16653, S13-10592C, and S14-15138R. Using these lines allows us to incorporate conventional, RR1, R2Y, and STS herbicide tolerances into our breeding program along with CLB resistance. |
| Did this project meet the intended Key Performance Indicators (KPIs)? List each KPI and describe progress made (or not made) toward addressing it, including metrics where appropriate.  |
| *KPI1: A regional variety trial will be conducted, using core commercial varieties, advanced breeding lines, and plant introductions, where natural disease reactions will be recorded and compiled in an annual publication for public researchers, extension personnel, and farmers that is made available for inclusion in each state’s SVT publication or similar venue, that provides farmers with variety choices that are more resistant and thus more profitable.* **Regional variety trials were conducted again during the 2020 growing season. The varieties included breeder selections and commercial varieties, with the majority of entries originating from University of Missouri breeding program. Most trial locations had Cercospora leaf blight disease pressure and were rated a minimum of once. We are currently awaiting data from cooperators for compilation and analysis. Results from previous years indicate that sources of CLB and other disease resistance are available for growers.***KPI2: Consistency of disease reactions among locations will be compared and promising plant introductions, germplasm, or cultivars with stable resistance across environments will be identified for breeding stock and results shared with private and public soybean breeders to incorporate resistance into commercial varieties that benefit farmers.***As mentioned in the previous section, we have identified breeding stock (PIs) that is resistant to CLB. Soybean breeders (Chen, Buckley, and Koebernick) are moving forward with selections identified in this project for incorporation into elite material. Publicly available varieties have been identified with CLB and other disease resistance. Once the publications are released by the J. Crop Improv., the information will be freely available to public and private breeders worldwide.***KPI3: Release of high yielding lines with CLB and/or improved FLS resistance is expected in 2020 which can result in greater control of these diseases.***Dr. Chen releases lines as described above annually that were developed through this project.***KPI4: By the end of 2018 growing season, soybean producers, breeders, and consultants in the Mid-South should have begun using confirmation of QTL/markers for CLB and FLS resistance and regional evaluation of breeding lines for resistance and yield is expected in 2019 that can result in seed company offerings to farmers where this resistance is needed to avoid significant yield loss.***Identification of QTL markers for CLB has been hindered by the discovery of at least three different *Cercospora* spp. associated with the disease. Work continues with a cercosporin screening assay that could conceptually be effective at screening varieties for resistance to all cercosporin-producing pathogens involved. Genetic characterization of *Cercospora* spp. associated with CLB will elucidate genome sections involved in host/pathogen relationships and create baseline information to move forward with identifying QTLs.***KPI5: Top performing advanced soybean lines which have a significant level of resistance to stink bugs and are appropriate for each state’s growing conditions are slated for development by 2022 which would represent a significant breakthrough in pest control i.e. a class of insects currently only partially controlled by insecticides.***We have identified sources of resistance (PIs) to stink bugs. Dr. Chen has made crosses between resistant material and advanced selections that were evaluated during the 2020 growing season. Seed was increased and evaluated in multiple locations during the 2020 season. Please refer to the stink bug section above for more information.**  |
| Expected Outputs/Deliverables - List each deliverable identified in the project, indicate whether or not it was supplied and if not supplied, please provide an explanation as to why. |
| *D1: Useful information concerning varietal resistance to multiple diseases will be generated for utilization by stakeholders.* **Supplied.** *D2: In the short term, important disease resistance data will be generated for new plant introductions (breeding stock) and selections to serve as a guide for breeder selections and longer term goals.* **Supplied.***D3: Breeding efforts are expected to identify resistance to Cercospora leaf blight in the short term.* **Supplied.** *Plant introductions (PIs) from GRIN and advanced breeding lines will be screened for CLB and resistant lines will be used a source for future research.* **Supplied.** *A total of 580 PIs will be screened and used for association mapping for CLB and those PIs have 50K SNP chip data available.* **Partially supplied. The 50K SNP chip data needs to be applied to the disease ratings. This will be addressed in the last year of the project.** *Interaction between CLB and purple seed stain (PSS) will be studied using advanced breeding lines as well as PIs.* **Not supplied. We have not had enough purple stain in the trials to determine the relationship between CLB and PSS.** *Identification of QTL/markers for CLB and FLS and the development and release of high yielding germplasm lines /cultivars resistant to CLB and FLS are expected in the long term.* **Partially supplied. Although we have identified lines/cultivars resistant to CLB, QTL have not been identified for CLB yet. This was a long term objective of the project that we will attempt to address in the final year.** *Breeders will work closely with plant pathologists to observe if reactions to CLB vary and observe possible isolate variations.* **Supplied. Our extensive collection of Cercospora isolates will shed light on species variation with location.***D4: The key outcome will be high yielding, locally adapted soybean cultivars that are resistant to both stink bugs and diseases. In addition, a set of germplasm will be created to easily incorporate resistance into new cultivars.* **Partially supplied. We have identified disease resistance in publicly available lines and breeding material. Breeders have already incorporated these traits into advanced lines. Dr. Chen has begun incorporating stink bug resistant material into his variety development program.***D5: Once resistance has been identified, our future approach will be to identify and map markers contributing to stink bug and disease resistance and to use marker assisted selection (MAS) to pyramid beneficial genes into current high-yielding adapted cultivars. By using MAS, it is possible to quickly screen large quantities of plant materials and remove progeny lacking the marker prior to testing for phenotypic response.* **Not supplied. Stink bug resistance is complex and is not due to a single gene.  Further development and identification of stink bug resistant lines likely will allow this approach in the future.** *Development of recombinant inbred lines (RIL) for mapping CLB and FLS resistance and selection within advanced breeding populations for resistance is expected by the end of 2017.* **Supplied. Dr. Chen has advanced breeding lines with resistance to CLB and FLS.** *Confirmation of QTL/markers for CLB and FLS resistance and regional evaluation of breeding lines for resistance and yield is expected in 2019.* **Not supplied. Identification of QTL markers for CLB has been complicated by multiple species involved and delayed due to limited seed supply. Plans are to plant resistant and susceptible PIs in replicated field trials during 2021 in an attempt to develop QTLs.** *D6: Increase seed of promising stink bug resistant lines in winter nurseries for 2018.* **Supplied.***D7: Initiate mapping populations for stink bug resistance.* **Supplied.***D8: Make crosses to develop an initial set of stink bug tolerant lines with elite material to improve agronomic characteristics.* **Supplied.***D9: By the end of the 2016 growing season, preliminary mechanisms of resistance to stink bugs were identified and shared with the target audience. By the end of the 2018 growing season, specific mechanisms of resistance to stink bugs will be identified.* **Supplied. We know lines have reduced stink bug population growth due to lower egg deposition (antixenosis) and nymphal survival (antibiosis) and/or reduced seed damage due to less feeding (antixenosis).** *D10: The benefits of using stink bug and disease resistant varieties will be promoted directly to growers during field days and on-farm demonstrations. Results and pertinent project updates will be reported to the entire mid-South soybean industry in appropriate participating statewide media. For example, in Louisiana it would be the Louisiana Agriculture Magazine, the official publication of the Louisiana State University AgCenter; the Louisiana Soybean & Feed Grain Review, and at commodity and professional meetings, e.g., Louisiana Soybean and Grain Research and Promotion Board Annual Meeting, and the annual branch and national meetings of the Entomological Society of America.* Supplied. |
| What, if any, follow-up steps are required to capture benefits for all US soybean farmers?Describe in a few sentences how the results of this project will be or should be used. |
| Overall, the results obtained from these efforts will directly benefit soybean producers and seed companies in all states where stink bugs and these diseases are yield limiting pests. The benefits from these extensive research efforts will certainly impact the southern region states, but will ultimately impact the entire soybean industry. Public and private/seed company soybean breeders will utilize the germplasm and genetic markers developed by this project to ultimately develop commercial varieties available to producers that contain improved genetic resistance and utilize them to better control key disease and pests, and thereby result in higher yields and less use of fungicides and insecticides. |
| **List any relevant performance metrics not captured in KPI’s.** |
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| **Non-technical summary:** |
| The 5th growing season for this project has been completed and data is currently being compiled. Efforts from previous seasons identified plant introductions (breeding material) resistant to Cercospora leaf blight (CLB) and other foliar diseases. A simpler, improved rating scale was developed for evaluating CLB, a disease with multiple aboveground symptoms. Efforts will continue to identify markers for CLB resistance, which will greatly improve breeder efficiency. Advanced breeding lines and publicly available varieties have been identified with resistance to CLB and other diseases. Plant samples from multiple trial locations in 7 states have yielded pathogen isolate collections from 2018, 2019, and 2020. Isolates are currently being genetically characterized and compared across locations as well as screened for fungicide (QoI) resistance. We have identified publicly available sources of resistance to stink bugs. Crosses are advancing to produce elite, high yielding soybean varieties that will reduce the number of insecticide applications needed to protect the crop, reducing producer inputs while maximizing profits.  |