Southern Soybean Disease Workers Proceedings

Southern Soybean Disease Workers

3-2020

Proceedings of the 47th Annual Meeting, Southern Soybean Disease Workers (March 4-5, 2020, Pensacola Beach, Florida)

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PROCEEDINGS OF THE SOUTHERN SOYBEAN DISEASE WORKERS

47TH ANNUAL MEETING

March 4-5, 2020
Pensacola Beach, Florida

Proceedings of the Southern Soybean Disease Workers are published annually by the Southern Soybean Disease Workers.

2020 Southern Soybean Disease Workers Agenda, Pensacola Beach, Florida

Wednesday March 4, 2020

11:30 – 12:50 **Registration –** Tower Foyer

Emerald Coast
12:50 – 1:00 **Introductions** Burt Bluhm, SSDW President

Student Papers (moderator: Tom Allen)

1:00 – 1:15 **Fungicide efficacy on target spot in Tennessee soybean.** Ty Smith, H. Kelly, and Z. Hansen

1:15 - 1:30 **Temporal dynamics of *Neohydatothrips variabilis*, *Frankliniella tritici*, and *Frankliniella fusca* in South Central Wisconsin and the occurrence of Soybean vein necrosis virus.** Cristina Zambrana-Echevarria, S. Kaplan, R. L. Groves, and D. L. Smith

1:30 – 1:45 **Population distributions and densities of nematodes, and virulence phenotypes of soybean cyst nematode in Tennessee.** Rufus Akinrinlola, and H. Kelly

1:45 – 2:00 **Improving soybean white mold control by integrated management.** Wade Webster, B. Mueller, J. Gaska, D. Mueller, M. I. Chilvers, S. Conley, and D. L. Smith

2:00 – 2:15 **Assessment of QoI sensitivity and frogeye leaf spot race of *Cercospora sojina* in Georgia soybean.** Bennett Harrelson, A. Culbreath, R. Kemerait, Jr., and J. Buck

2:15 – 2:30 **Reduction of Pythium damping-off in soybean by biocontrol seed treatment.** Mirian F. Pimentel, E. Arnao, A. Warner, N. Elsharif, M. Chilvers, A. Robertson, J. Bond, and A. Fakhoury

2:30 – 2:45 **Understanding cercosporin self-resistance to identify novel tools to manage Cercospora leaf blight on soybean.** Maria Izabel Costa de Novaes, C. L. Robertson, V. P. Doyle, and S. Thomas-Sharma

2:45 – 3:00 **Evaluating the efficacy of soybean seed treatment on high and low vigor seed in Arkansas.** Samantha Segalin, J. C. Rupe, J. A. Rojas, and R. Holland

3:00 **BREAK – 30 min – poster viewing**

Student Papers – continued (moderator: Terry Spurlock)

4:00 – 4:15 **Impact of wheat on soybean cyst nematode (*Heterodera glycines* I.) populations in a soybean double cropping system.** Leonardo F. Rocha, M. F. Pimentel, J. P. Bond, and A. M. Fakhoury

4:15 – 4:30 **Using unmanned aerial systems and multispectral imagery to assess sudden death syndrome of soybean.** Lindsey McKinzie, A. M. Fakhoury, R. Li, and J. P. Bond

Contributed Papers (moderator: Terry Spurlock)

4:30 – 4:45 **Soybean rust – Scourge of Alabama.** Ed J. Sikora, D. Delaney, and K. Connor

4:45 – 5:00 **Management of SCN and SDS with nematode-protectant seed treatments across multiple environments.** Kaitlyn M. Bissonnette, Y. Kandel, M. Chilvers, N. Kleczewski, D. Mueller, D. Smith, D. Telenko, and A. Tenuta

5:00 – 5:15 **Determining inoculum density of *Xylaria* sp., the taproot decline pathogen, in soil under various crop rotation systems.** Aline Bronzato-Badial, K. Phillips, T. H. Wilkerson, S. Popescu, and M. Tomas-Peterson

5:15 **Adjourn**

6:00 **Reception** – Pergola or White Sands

7:00 **Banquet** – White Sands

Thursday, March 5, 2020

7:00 – 8:15 **Breakfast** – White Sands

Emerald Coast
Contributed Papers – continued (moderator: Travis Faske)

8:15 – 8:30 **Impact of cultivar on soybean foliar and seed diseases in Arkansas.** John C. Rupe, R. T. Holland, and J. A. Rojas

8:30 – 8:45 **A new pathosystem to study the plant-fungal interactions underlying Cercospora leaf blight of soybean.** Kona Swift, and B. Bluhm

8:45 – 9:00 **Thoughts on southern blight: Should we be concerned about southern blight?** Tom W. Allen, W. L. Solomon, and B. A. Burgess

9:00 – 9:15 **From plots to strips: Six years of fungicide trials.** Terry N. Spurlock, A. C. Tolbert, and R. C. Hoyle

9:15 – 9:30 **Meta-analysis of soybean yield response to foliar fungicides evaluated from 2005 to 2018 in the United States and Canada.** Yuba K. Kandel, C. Hunt, K. Ames, N. Arneson, C. A. Bradley, E. Byamukama, A. Byrne, M. I. Chilvers, L. Giesler, J. Halvorson, D. C. Hooker, N. M. Kleczewski, D. K. Malvick, S. Markell, B. Potter, W. Pederson, D. L. Smith, A. U. Tenuta, D. E. P. Telenko, K. A. Wise, and D. S. Mueller

9:30 – 9:45 **On the road in Louisiana: Taking the research station to farms.** Trey Price, M. A. Purvis, D. A. Ezell, G. B. Padgett, M. Foster, and J. Hebert

9:45 – 10:00 **The next super model: Development of a flexible framework for multiple disease models in soybean.** Damon L. Smith, J. Willbur, M. Chilvers, M. Kabbage, S. P. Conley, D. Mueller, and R. Schmidt

10:00 – 10:15 **IPM implementation in Tennessee.** Heather M. Kelly, S. Stewart, K. Vail, D. Hensley, S. Steckel, A. McClure, and T. Raper

10:15 – 10:30 **BREAK – poster viewing**

10:30 – 10:45	**Reproduction potential and survival of soybean nematodes in row rice.** Travis Faske, K. Brown, and N. Bateman

Contributed Papers – continued (moderator: Tom Allen)

10:45 – 11:00	**Initial research with peracetic acid as a disease management tool in soybeans and other legume crops.** Vijay K. Choppakatla
11:00 – 11:15	**FMC fungicide offerings update.** Matthew Wiggins
11:15 – 11:45	**Industry updates – 30 min**
11:45 – 1:00	**Lunch – on your own**
1:00 – 2:00	**Student Paper Awards/SSDW Business Meeting** **-Old Business** **-New Business** **-Committee Reports** **-Vice President election** **-Treasury Report** **-Graduate student competition awards** **-Adjourn**

Poster(s):

Extension efforts in disseminating nematode survey results. Rachel Guyer, R. Akinrinlola, and H. Young

Assessing the role of weathering on the grain quality of soybean varieties in the Mississippi Delta. Tessie Wilkerson, T. W. Allen, and B. A. Burgess.

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Abstracts of Presented Papers

Abstracts for presented posters

Southern United States Soybean Disease Loss Estimates for 2019

Allen, T.W.[1], Bissonnette, K.[2], Bradley, C.A.[3], Damicone, J.P.[4], Dufault, N.S.[5], Faske, T.R.[6], Isakeit, T.[8], Kemerait, R.C.[9], Koehler, A.[10], Mehl, H.L.[11], Mueller, J.D.[12], Padgett, G.B.[7], Price, P.P.[13], Sikora, E.J.[14], Small, I.M., Thiessen, L.[15], and Young, H.[16]

[1]Mississippi State University, Stoneville, MS; [2]University of Missouri, Columbia, MO; [3]University of Kentucky, Princeton, KY; [4]Oklahoma State University, Stillwater, OK; [5]University of Florida, Gainesville, FL; [6]University of Arkansas, Lonoke, AR; [7]Louisiana State University, Baton Rouge, LA; [8]Texas A&M University, College Station, TX; [9]University of Georgia, Tifton, GA; [10]University of Delaware, Newark, DE; [11]Virginia Tech, Suffolk, VA; [12]Clemson University, Blackville, SC; [13]Louisiana State University, Winnsboro, LA; [14]Auburn University, Auburn, AL; [15]North Carolina State University, Raleigh, NC; [16]University of Tennessee, Jackson, TN

The Southern Soybean Disease Workers (SSDW) have published soybean disease loss estimates for the southern United States since 1974. Summaries of the results from between 1977 and 2014 have been published in numerous refereed scientific journals (11; 13-22; 24-25). The annual losses from between 2015 and 2019 have been presented annually in the SSDW proceedings (1-2; 4-5) and most recently in a publication that included the estimates from 2010 to 2014 in Plant Health Progress that includes the loss estimates from the entire soybean production region including the southern and northern states (3). A website through the University of Illinois Extension Service summarizes the estimated yield losses from both the northern and southern U.S. and includes data from 1996 through 2014. The website can be accessed at:

http://extension.cropsci.illinois.edu/fieldcrops/diseases/yield_reductions.php

The additional supporting presentation of loss estimates were included in the annual proceedings of the SSDW as well as some university-related sources (6-10; 12; 23).

The disease loss estimates contained in the current publication were obtained through various methods. Plant pathologists with soybean pathology responsibilities were queried in December 2019 to provide the estimates of loss from their respective states. Most of the individuals relied on multiple methodologies to arrive at estimates. The methods employed included: field surveys, plant disease diagnostic clinic samples, variety trials, and questionnaires to Cooperative Extension staff, research plots, grower demonstrations, private crop consultant reports, foliar fungicide trials, sentinel plot data, variety trial ratings, and "pure guess". The production figures for each state were collected from the USDA/NASS website in January 2020. Production losses were based on estimates of yield in the absence of disease. One additional topic that was added to the 2018 data and also included for the 2019 presentation included a comparison of environment from within each state. To keep data collection and reporting simple a centroid from each state was determined based on designated geographic centroid for each state and were obtained from Wikipedia (https://en.wikipedia.org/wiki/List_of_geographic_centers_of_the_United_States). In situations where environmental data were not available in close proximity to the centroid a different location was selected. In 2019, several different weather stations were used as compared to 2018 due to the missing data from specific weather stations. However, every attempt was made to use the same weather station to maintain data integrity between seasons. State, county and designated centroid location are presented in Table 1. Environmental data representing the most current 30-year normal (1981-2010) were downloaded for each corresponding location from the National Centers for Environmental Information data tools which includes climate normal (https://www.ncdc.noaa.gov/cdo-web/datatools/normals).

Production losses associated with disease severity estimates were based on the formula used to derive production losses: potential production without disease loss = actual production ÷ (1- percent loss) (decimal fraction). Rounding errors may occur in the tables provided below due to the presence of "trace" estimates of disease which were estimated by the state pathologist rather than assigning the value that had been used in the past to be approximately 1×10^{-9}. Total losses in the form of percent disease loss by state and total losses in millions of bushels were determined by averaging the loss by state with the inclusion of the trace estimates.

Table 1. Location of state centroids used to download environmental data for the 2019 season from each state in the southern soybean production system.

State	County/Parish	Location
Alabama	Chilton	Clanton
Arkansas	Pulaski	Little Rock
Delaware[a]	Sussex	Georgetown
Florida[a]	Leon	Tallahassee
Georgia	Twiggs	Macon
Kentucky	Bayle	Danville
Louisiana[a]	Rapides	Alexandria
Maryland[a]	Baltimore	Baltimore
Mississippi[b]	Rankin	Jackson
Missouri	Miller	Jefferson City
North Carolina	Chatham	Sanford
Oklahoma	Oklahoma	Oklahoma City
South Carolina	Richland	Columbia
Tennessee	Rutherford	Murfreesboro
Texas	McCulloch	Brady
Virginia[a]	Buckingham	Lynchburg

[a] Location moved based on lack of 30-year normal data, lack of temperature data for 2018, or a lack of a complete set of precipitation data for 2018 from the corresponding defined state centroid.

[b] Location moved between 2018 and 2019 based on lack of data coverage during the 2019 season.

The 2019 total acres harvested, average yield (bushels/Acre), and total production (yield in bushels) from each state are presented in Table 2. Soybean acreage in the sixteen southern states in decreased compared to that reported in 2018 by 17.6% (1). Almost all of the southern states save for FL and KY reported a reduction in the overall number of harvested acres between 2018 and 2019. Much of this was the result of a delayed crop and in situations in the Deep South was the result of continued periods of flooding and numerous acres that were not planted to any crop. The 2019 average per acre soybean yield was 39.1 bushels per acre, a 7.6% decrease in average yield compared to the 2018 average yield (42.3 bu/A). As opposed to 2018, when one southern state recorded a record yield, none of the 16 southern states recorded a record yield during 2019. In 2019, more than 751 million bushels were harvested from approximately 16.9 million acres from the 16 southern states accounting for a 21% decrease in the total harvest compared to 2018.

Percentage loss estimates from each state are specific as to causal organism or the common name of the disease (Table 3). The total estimated average percent disease loss for 2019 was 44% less than the losses compared to 2018. As a whole, 13 states reported an increase in percent disease losses compared to 2017 (AL, AR, DE, FL, KY, LA, MD, MS, NC, OK, SC, TN, TX). In addition, and one important note regarding the diseases observed and reported during 2018, a greater number of states continue to report losses associated with target spot. In 2016 only seven states reported observing target spot while this number increased to nine states in 2017 and increased to 10 states in 2018. An increasing number of states reporting this specific disease indicates that target spot is becoming a much more widespread concern. In terms of the top five diseases encountered during 2019, some shifting occurred between what was observed in 2018 and the 2019 season, mostly due to the differences in environment encountered between the two seasons. Phomopsis seed decay, soybean cyst nematode (SCN), root-knot nematode, Cercospora leaf blight, and purple seed stain were the top five diseases, respectively during 2018. Two of the top five diseases were similar between 2018 and 2019, but the seed rot observed in most states throughout the southern region accounted for a major increase in the estimated losses associated with Phomopsis seed decay during 2018 that was not observed during 2019. The top five diseases in order of importance during 2019 based on estimated losses in millions of bushels were: Soybean cyst nematode, root-knot nematode, Cercospora leaf blight, seedling diseases, and frogeye leaf spot. Breaking the diseases evaluated down into plant categories impacted by the diseases within that specific category nematode diseases (41.4%), root diseases (13.4%), foliar diseases (25.3%), seedling diseases (6.1%), and seed diseases (7.7%) highlights the importance of specific groups of diseases and which disease areas are causing the greatest estimated losses in a given year/season. Diseases included in the category “other diseases” could not be separated into separate categories and therefore were not included in any single category.

In terms of the disease losses in millions of bushels, the 2019 disease losses accounted for 51.04 million bushels in lost potential production, a 53% reduction compared to the estimated losses incurred during 2018 (Table 4).

Environmental conditions during 2019 were extremely different when compared to the environment encountered during 2018. In general, less rainfall was received across the conducive for widespread development of seed rot issues throughout the southern soybean production system (Table 5). In addition, temperature for 2019 was also compared to the 30-year normal (1981-2010). In general, looking across the entire year, based on temperature averages for the whole year, three months, March, June, and November, were below the 30-year normal temperatures across the region. Conversely, the remainder of the months had temperatures above normal with the greatest temperature increases in October (7°F) and December (4°F). Looking at temperature data by month, seven months had average temperature increases with three of those months being May, June and July across the region. Total rainfall varied greatly by state with eight states (AR, LA, MO, MS, NC, OK, SC, and TN) received rainfall in excess of the 30-year normal by between less than 1 (NC) and 14.2 inches (TN). The remaining eight states received rainfall totals that were below the 30-year normal by between 1.1 (GA) and 16.9 inches (FL).

Acknowledgments

Funding was provided from the United Soybean Board to collate the losses across the region as part of a larger effort to collect losses from the entire soybean producing area in the U.S. The members of the SSDW Disease Loss Estimate Committee see value in continuing to collect the estimates on an annual basis and will continue to seek funding sources to support the effort in the future.

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Table 2. Soybean production in 16 southern states in 2019.

State	**Acres (1,000s)[a]**	**Bu/Acre[b]**	**Yield in Bu (1,000s)[c]**
Alabama	260 (-)	36 (-5)	9,360 (-)
Arkansas	2,610 (-)	49 (-2)	127,890 (-)
Delaware	153 (-)	47 (+5)	7,191 (+)
Florida	12	32 (-2)	384 (-)
Georgia	93 (-)	29 (-11)	5,400 (-)
Kentucky	1,690 (+)	46 (-6)	77,740 (+)
Louisiana	860 (-)	48 (-4)	41,280 (-)
Maryland	475 (-)	45 (-3.5)	20,900 (-)
Mississippi	1,630 (-)	50 (-4.5)	81,500 (-)
Missouri	4,840 (-)	45 (-4)	222,640 (-)
North Carolina	1,520 (-)	34 (-6)	53,200 (-)
Oklahoma	440 (-)	30 (1)	12,760 (-)
South Carolina	320 (-)	26 (-3.5)	8,320 (-)
Tennessee	1,370 (-)	47 (+1)	64,390 (-)
Texas	135 (-)	28 (-4)	2,044 (-)
Virginia	560 (-)	34 (-9)	19,040 (-)
TOTAL	**16,906**		**751,336**
		Avg. 39.1 (-3.2)	

[a] Difference from 2018 indicated in parentheses as either a decrease (-) or increase (+).

[b] Difference from 2018 indicated in parentheses as either a decrease (-) or increase (+) in addition to the value difference between 2018.

[c] Difference from 2018 indicated in parentheses as either a decrease (-) or increase (+).

Table 3. Estimated percentage loss of soybean yield due to diseases from 16 southern states during 2019.

	% yield suppression by state																
Disease	**AL[a]**	**AR**	**DE**	**FL**	**GA**	**KY**	**LA**	**MD**	**MS**	**MO**	**NC**	**OK**	**SC**	**TN**	**TX**	**VA**	**AVG**
Anthracnose	0.10	0.10	0.00	0.10	0.50	0.00	0.10	0.00	0.20	0.00	0.05	0.20	0.03	0.25	0.00	0.50	0.13
Bacterial diseases	0.00	0.01	0.00	0.10	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.05	0.01	0.00	0.00	0.00	0.01
Brown stem rot	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cercospora leaf blight	1.00	1.00	0.01	0.50	0.50	0.03	2.00	0.10	1.30	1.00	0.70	0.50	0.50	0.03	0.00	0.25	0.59
Charcoal rot	0.20	0.04	0.05	0.00	0.10	0.10	1.00	0.01	0.01	0.00	0.00	1.00	0.10	1.00	0.01	0.10	0.23
Downy mildew	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00
Frogeye leaf spot	0.01	0.50	0.00	0.10	0.10	0.90	0.50	0.00	0.00	0.00	0.30	0.05	0.03	1.20	0.10	0.50	0.27
Fusarium wilt and root rot	0.05	0.20	0.50	0.00	0.00	0.00	0.05	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.05
Other diseases[b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.00	0.00
Phomopsis seed decay	0.05	0.08	0.10	0.00	0.10	0.03	0.50	0.50	0.05	0.00	0.80	1.00	1.00	0.00	0.00	0.01	0.26
Phytophthora root and stem rot	0.00	0.08	0.00	0.10	0.00	0.40	0.05	0.00	0.00	0.00	0.70	0.05	0.00	0.02	0.00	0.00	0.09
Pod and stem blight	0.01	0.05	0.05	0.01	1.00	0.08	0.10	0.50	0.00	0.00	0.70	0.50	0.30	0.05	0.00	0.10	0.22
Purple seed stain	0.20	0.08	0.10	0.00	0.10	0.01	0.10	0.10	0.50	0.00	0.50	0.75	0.10	0.00	0.01	0.01	0.16
Reniform nematode	0.25	0.30	0.00	0.25	0.10	0.00	1.00	0.00	0.03	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.18
Root-knot nematode	0.50	4.00	0.50	0.50	2.00	0.00	1.50	0.01	1.25	0.01	1.00	0.50	3.00	0.01	0.00	1.00	0.99
Soybean cyst nematode	0.15	0.50	0.00	0.00	0.00	2.50	0.00	0.05	0.03	3.00	2.00	0.75	2.00	1.75	0.00	2.00	0.92
Other nematodes[c]	0.00	0.01	0.10	0.00	0.00	0.00	0.10	0.01	0.00	0.00	0.25	0.00	2.00	0.00	0.00	0.50	0.19
Rhizoctonia aerial blight	0.10	0.05	0.00	0.00	0.00	0.00	0.75	0.00	0.10	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.06
Sclerotinia stem rot (white mold - *Sclerotinia sclerotiorum*)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seedling diseases	0.30	0.30	1.00	0.10	0.00	0.80	0.05	0.50	0.60	0.50	0.30	0.20	0.10	0.50	0.00	0.10	0.33
Septoria brown spot	0.00	0.30	0.00	0.01	0.00	0.30	0.30	0.00	0.80	0.00	0.10	0.75	0.10	0.75	0.00	0.10	0.22
Southern blight	0.30	0.40	0.00	0.25	0.25	0.00	0.20	0.00	0.75	0.00	0.00	0.01	0.10	0.00	0.01	0.01	0.14
Soybean rust	0.05	0.00	0.00	0.10	0.10	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Stem Canker	0.01	0.10	0.10	0.00	0.00	0.50	0.00	0.10	0.00	0.00	0.10	0.10	0.05	0.50	0.00	0.50	0.13
Sudden death syndrome	0.01	0.00	0.01	0.00	0.00	0.30	0.05	0.01	0.01	0.50	0.00	0.01	0.01	0.00	0.00	0.10	0.06
Taproot decline	0.15	0.30	0.00	0.00	0.00	0.00	1.50	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Target spot	0.00	0.08	0.00	0.00	0.00	0.08	0.10	0.00	0.02	0.00	0.00	0.00	0.30	0.25	0.00	0.01	0.05
Virus Diseases[d]	0.05	0.00	0.00	0.10	0.00	0.05	0.00	0.00	0.00	0.00	0.20	0.05	0.05	0.00	0.00	0.00	0.03
Total disease %	**3.49**	**8.48**	**2.52**	**2.22**	**4.85**	**6.08**	**10.10**	**1.95**	**5.94**	**5.02**	**7.74**	**6.47**	**10.79**	**6.30**	**0.15**	**5.80**	**5.50**

[a] Rounding errors may exist since some numbers presented carry decimal places beyond the hundredths place.

[b] Other diseases listed included: Phymatotrichopsis root rot (TX), red crown rot (MS, NC).

[c] Other nematodes listed included: Columbia lance nematode (NC, SC), lesion nematode (AR, DE, MD, MO, SC, VA), sting nematode (VA), stubby root nematode (SC, VA).

[d] Virus diseases listed included: *Bean pod mottle virus* (KY, MS, NC, SC), *Soybean mosaic virus* (DE, MD, MS, NC, SC), *Soybean vein necrosis virus* (DE, KY, MD, MS, NC, OK), *Tobacco ringspot virus* (KY, NC, SC).

Table 4. Estimated suppression of soybean yield (Millions of Bushels) as a result of disease during 2019.

	yield suppression by state (millions of bushels)																
Disease	**AL**[a]	**AR**	**DE**	**FL**	**GA**	**KY**	**LA**	**MD**	**MS**	**MO**	**NC**	**OK**	**SC**	**TN**	**TX**	**VA**	**TOTAL**
Anthracnose	0.01	0.14	0.00	0.00	0.01	0.00	0.05	0.00	0.17	0.00	0.03	0.03	0.00	0.17	0.00	0.10	**0.72**
Bacterial diseases	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	**0.05**
Brown stem rot	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Cercospora leaf blight	0.10	1.40	0.00	0.00	0.01	0.02	0.92	0.02	1.13	2.29	0.39	0.07	0.05	0.02	0.00	0.05	**6.47**
Charcoal rot	0.02	0.06	0.00	0.00	0.00	0.08	0.46	0.00	0.01	0.00	0.00	0.14	0.01	0.69	0.00	0.02	**1.49**
Downy mildew	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Frogeye leaf spot	0.00	0.70	0.00	0.00	0.00	0.74	0.23	0.00	0.00	0.00	0.17	0.01	0.00	0.82	0.00	0.10	**2.79**
Fusarium wilt and root rot	0.00	0.28	0.04	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	**0.37**
Other diseases[b]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	**0.01**
Phomopsis seed decay	0.00	0.11	0.01	0.00	0.00	0.02	0.23	0.11	0.04	0.00	0.45	0.14	0.09	0.00	0.00	0.00	**1.22**
Phytophthora root and stem rot	0.00	0.11	0.00	0.00	0.00	0.33	0.02	0.00	0.00	0.00	0.39	0.01	0.00	0.01	0.00	0.00	**0.88**
Pod and stem blight	0.00	0.07	0.00	0.00	0.03	0.07	0.05	0.11	0.00	0.00	0.39	0.07	0.03	0.03	0.00	0.02	**0.87**
Purple seed stain	0.02	0.11	0.01	0.00	0.00	0.01	0.05	0.02	0.43	0.00	0.28	0.11	0.01	0.00	0.00	0.00	**1.05**
Reniform nematode	0.02	0.42	0.00	0.00	0.00	0.00	0.46	0.00	0.02	0.00	0.00	0.00	0.09	0.00	0.00	0.00	**1.02**
Root-knot nematode	0.05	5.59	0.04	0.00	0.06	0.00	0.69	0.00	1.08	0.01	0.56	0.07	0.28	0.00	0.00	0.20	**8.64**
Soybean cyst nematode	0.01	0.70	0.00	0.00	0.00	2.07	0.00	0.01	0.03	6.88	1.12	0.11	0.19	1.20	0.00	0.40	**12.72**
Other nematodes[c]	0.00	0.01	0.01	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.14	0.00	0.19	0.00	0.00	0.10	**0.50**
Rhizoctonia aerial blight	0.01	0.07	0.00	0.00	0.00	0.00	0.34	0.00	0.09	0.00	0.01	0.00	0.00	0.00	0.00	0.00	**0.52**
Sclerotinia stem rot (white mold - *Sclerotinia sclerotiorum*)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.01**
Seedling diseases	0.03	0.42	0.07	0.00	0.00	0.66	0.02	0.11	0.52	1.15	0.17	0.03	0.01	0.34	0.00	0.02	**3.55**
Septoria brown spot	0.00	0.42	0.00	0.00	0.00	0.25	0.14	0.00	0.69	0.00	0.06	0.11	0.01	0.52	0.00	0.02	**2.21**
Southern blight	0.03	0.56	0.00	0.00	0.01	0.00	0.09	0.00	0.65	0.00	0.00	0.00	0.01	0.00	0.00	0.00	**1.35**
Soybean rust	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.06**
Stem Canker	0.00	0.14	0.01	0.00	0.00	0.41	0.00	0.02	0.00	0.00	0.06	0.01	0.00	0.34	0.00	0.10	**1.10**
Sudden death syndrome	0.00	0.00	0.00	0.00	0.00	0.25	0.02	0.00	0.01	1.15	0.00	0.00	0.00	0.00	0.00	0.02	**1.46**
Taproot decline	0.01	0.42	0.00	0.00	0.00	0.00	0.69	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.38**
Target spot	0.00	0.11	0.00	0.00	0.00	0.07	0.05	0.00	0.01	0.00	0.00	0.00	0.03	0.17	0.00	0.00	**0.44**
Virus Diseases[d]	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.11	0.01	0.00	0.00	0.00	0.00	**0.17**
Total disease %	**0.34**	**11.85**	**0.19**	**0.01**	**0.14**	**5.04**	**4.64**	**0.43**	**5.15**	**11.51**	**4.33**	**0.91**	**1.01**	**4.33**	**0.01**	**1.17**	**51.04**

[a] Rounding errors may exist since some numbers presented carry decimal places beyond the hundredths place.

[b] Other diseases listed included: Phymatotrichopsis root rot (TX), red crown rot (MS, NC).

[c] Other nematodes listed included: Columbia lance nematode (NC, SC), lesion nematode (AR, DE, MD, MO, SC, VA), sting nematode (VA), stubby root nematode (SC, VA).

[d] Virus diseases listed included: *Bean pod mottle virus* (KY, MS, NC, SC), *Soybean mosaic virus* (DE, MD, MS, NC, SC), *Soybean vein necrosis virus* (DE, KY, MD, MS, NC, OK), *Tobacco ringspot virus* (KY, NC, SC).

Table 5. Deviation of the 2019 temperature from the 30-year normal and the total precipitation for 2019 and the 30-year normal from each of the 16 southern soybean producing states based on data downloaded from the centroid for each respective state.

	Deviation from the 30-year temperature norm (°F)[a]												**Total precip (in)[b]**		
State	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**2019**	**30-year**	**Deviation**
Alabama	1.1	8.1	-1.5	1.2	3.2	0.3	0.5	2.6	9.6	3.4	-1.4	4.0	42.9 (2)	57.9	**-15.0**
Arkansas	-0.3	1.3	-3.5	-0.2	0.7	-2.2	-3.3	-0.8	6.1	-2.0	-3.8	2.3	62.1 (7)	48.8	**+13.3**
Delware	3.1	3.9	1.0	6.1	3.9	1.6	5.3	1.1	4.8	4.1	-3.3	3.8	39.3 (4)	43.8	**-4.5**
Florida	0.7	6.1	-1.2	0.1	4.5	1.1	2.1	1.3	6.6	5.0	-2.6	2.8	41.2 (4)	58.1	**-16.9**
Georgia	2.3	4.7	0.1	2.2	6.0	1.0	2.4	2.6	10.3	6.4	-2.0	4.1	44.6 (5)	45.7	**-1.1**
Kentucky	3.6	5.1	-4.8	2.1	2.8	-2.2	2.3	1.0	9.7	5.9	-2.5	6.1	41.0 (5)	46.4	**-5.4**
Louisiana	0.3	2.8	-1.9	-1.9	0.0	-0.5	-2.0	0.3	5.8	-0.6	-2.2	4.0	65.3 (6)	55.9	**+9.3**
Maryland	0.2	1.5	-0.3	6.0	4.2	2.9	4.5	3.3	7.6	5.2	-2.1	3.1	38.1 (6)	41.9	**-3.8**
Missouri	-3.8	-6.6	-7.2	0.3	-1.6	-2.8	-0.5	-1.6	5.3	-3.6	-4.8	7.1	48.9 (6)	44.0	**+4.9**
Mississippi	1.4	6.9	-1.1	1.0	2.6	0.3	0.5	1.5	8.5	1.1	-1.8	4.2	64.2 (7)	54.1	**+10.1**
North Carolina	2.0	4.3	-2.6	0.8	4.9	-1.3	1.1	-0.9	5.4	4.9	-4.7	3.2	47.0 (5)	46.2	**+0.8**
Oklahoma	-2.3	-6.8	-5.5	-0.3	-3.4	-2.6	-1.1	-0.6	4.1	-4.2	-2.0	3.4	45.3 (5)	36.5	**+8.8**
South Carolina	1.5	5.7	0.6	1.9	6.2	-0.5	2.0	3.0	8.6	6.0	-4.2	4.5	53.2 (6)	46.3	**+6.9**
Tennessee	0.2	3.8	-3.3	0.5	3.0	-1.3	-0.8	-0.6	7.6	3.8	-6.9	6.5	67.6 (7)	53.4	**+14.2**
Texas	-1.8	-0.6	-4.3	-2.3	-6.0	-1.7	-0.9	1.6	4.2	-4.4	-2.5	4.4	20.0 (2)	27.6	**-7.6**
Virginia	-0.5	3.3	-2.2	3.6	6.3	0.0	4.0	3.0	8.9	4.4	-4.8	1.0	39.0 (4)	41.6	**-2.6u**
Avg.	**0.5**	**2.7**	**-2.4**	**1.3**	**2.3**	**-0.5**	**1.0**	**1.1**	**7.1**	**2.2**	**-3.2**	**4.0**	--	--	--

[a] Deviations of temperature were calculated based on subtracting the average temperature for each month from the 30-year normal. Negative numbers are deviations below the normal and positive numbers are deviations above the normal temperature for the 30-year period from 1981-2010.

[b] Numbers in parentheses equal the number of months where the total rainfall was over the 30-year normal for the given location.

Fungicide Efficacy on Target Spot in Tennessee Soybean

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Target spot (TS), caused by the fungus *Corynespora cassiicola*, is a foliar disease of cotton and soybean. Over recent years, TS has become a disease of concern in soybean production systems. Data for fungicide sensitivity and understanding potential impact on yield is lacking for *C. cassiicola*. The objective of this study was to conduct fungicide screening to monitor sensitivity in *C. cassiicola* in Tennessee soybean production. The sensitivity of 30 *C. cassiicola* isolates to eight technical grade fungicides across multiple fungicide groups (FRAC Groups 1, 3, 7, and 11) was evaluated based on mycelial growth inhibition assays. The EC_{50} of each fungicide was calculated. Field trials were also conducted at three locations for soybean in 2018 and 2019. Five fungicide tank mixes were evaluated for control of TS among 5 soybean varieties of differing susceptibility. TS in soybean was decreased by all products except Domark, but only Miravis TOP protected yield in both years. Pyraclostrobin, thiophanate methyl, and azoxystrobin had the highest EC_{50} values. *In vitro* and field evaluations suggest that products that contain FRAC groups 7 and 3 have the potential to better protect yield from target spot compared to products containing groups 11 or 1 fungicides.

Temporal Dynamics of *Neohydatothrips variabilis*, *Frankliniella tritici*, and *Frankliniella fusca* in South Central Wisconsin and the Occurrence of *Soybean vein necrosis virus*

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Soybean vein necrosis virus (SVNV) is a recently described virus infecting *Glycine max* (L.) Merr. (soybean) that has spread throughout the major soybean growing regions since its initial detection in 2008. It is one of two orthotospoviruses known to infect soybean (the other is *Tomato spotted wilt virus*). SVNV is transmitted in a persistently propagative manner by three species of thrips (Thysanoptera: Thripidae): *Neohydatothrips variabilis*, *Frankliniella tritici*, and *Frankliniella fusca*. Symptoms caused by SVNV infection in soybean start as vein-associated chlorosis that later expand to become necrotic. These are typically observed late in the season in Wisconsin. Thrips populations have been reported to increase in soybean before the onset of SVNV symptoms. The aim of this study was to assess the temporal patterns of *N. variabilis*, *F. tritici*, and *F. fusca* arrival associated with the timing of SVNV detection and onset of symptoms using sentinel crops in South Central Wisconsin. A field trial of eight replicated plots was established during the growing season in 2017, 2018 and 2019 at the Arlington Agricultural Experiment Station (Columbia County, Wisconsin). Experimental plots measured 36 m^2 and consisted of eight, 0.76m rows. Four of the rows located in the center of the plots were planted with *Vigna unguiculata* (cowpea) var. 'California Blackeye #5', as the sentinel crop, while the two outer rows were planted with *G. max* var. 'Dwight'. Yellow sticky panel traps (362 cm^2) were used to capture dispersing thrips species. Replicate traps were placed between the rows of cowpea and changed weekly. Numbers of adult thrips of *N. variabilis*, *F. tritici*, and *F. fusca* were tabulated by randomly sampling twenty squares (6.5 cm^2) from each panel trap. To determine the occurrence of SVNV, randomly selected, asymptomatic and virus-like symptomatic leaf tissue from cowpea and soybean were sampled weekly concomitant with panel traps. Nested RT-PCR, using primers targeting a region of the nucleoprotein gene, was performed for virus detection. In all three years, *F. tritici* comprised the majority of captures. However, SVNV was consistently associated with a population increase of *N. variabilis* captures. Surveying thrips populations and better determining the principle vector(s) of SVNV in the field could influence disease management strategies such as planting dates to avoid peak periods of thrips transmission, and the timing of insect management tactics to limit the transmission of this persistently transmitted, viral pathogen.

Nematode Population Distributions and Densities, and Virulence Phenotypes of Soybean Cyst Nematode in Tennessee

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Plant parasitic nematodes cause up to $8 billion crop yield loss in the United States annually, and soybean cyst nematode (SCN) is responsible for up to $1.5 billion of that amount. Monitoring these nematodes distributions and population densities is important in making management decisions. Additionally, understanding SCN virulence phenotypes (i.e. HG types or ability to reproduce on SCN-resistant soybeans) is essential for preventing yield loss by SCN. To this end, soil samples were collected across 18 counties in Tennessee in 2018 and 2019 and five counties in Kentucky in 2018. From each sample, 100 cm^3 soil was processed for the presence of plant parasitic nematodes, and HG type test was conducted for the SCN populations to identify their ability to reproduce on resistant soybean indicator lines.

For the 2018 samples, spiral nematodes occurred in 84% of samples, SCN in 47%, lesion in 25%, stunt in 20%, dagger in 8%, root-knot in 4%, and reniform in 4%. Their population densities (reported as juveniles in 100 cm^3 soil) ranged from 7 to 547 for spiral, 7 to 100 (115 to 4,569 eggs) for SCN, 7 to 62 for lesion, 7 to 69 for stunt, 7 to 23 for dagger, 23 to 446 for root-knot, and 38 to 324 for reniform nematodes. The HG type test results showed that five of the SCN samples tested were HG type 1.2.5.7, three were type 2.5.7 and one sample was type 7, and most of the samples had a female index value over 50% on PI88788 – the most commonly used resistance source. Population distributions and densities of the 2019 samples will also be presented. Growers are advised to take appropriate actions to avoid damage by this pathogen in fields where high densities were observed.

Improving Soybean White Mold Control by Integrated Management

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Sclerotinia stem rot (SSR; a.k.a. white mold) of soybean is caused by the fungal pathogen *Sclerotinia sclerotiorum*, which causes significant yield losses across the upper Midwest growing region. There is great interest in finding suitable management solutions for SSR, including combining cultural and chemical control methods together for an integrated approach. This study examined integrating row spacing (15 cm and 30 in), planting population (108,000 – 197,600 seeds/A), and foliar fungicide applications (growth stage applications and forecast-based applications). This work was conducted between 2017 and 2019 in multiple states to determine the impact that a fully integrated management strategy had on reducing disease severity index (DIX) while balancing yield potential. Locations were examined either for all three factors simultaneously (n=11 site-years; referred to as the fully integrated locations) or for two factors; planting population and fungicide application (n=8 site-years; referred to as the partially-integrated locations). Analysis was performed separately on locations where disease was present and where disease was absent. In the fully integrated site-years where SSR was present, the interaction of row spacing and population had a significant effect on both DIX ($P = 0.04$) and yield ($P < 0.01$). The level of DIX was lowest with a planting population of less than 138,000 seeds/A in a 30 in row spacing. Conversely, the level of DIX trended higher in the 15 in row spacing and was maximal when a planting population of 168,000 seeds/A was combined with the 15 in row spacing. Furthermore, the main effect of fungicide application had a significant effect on DIX ($P < 0.01$) and yield ($P < 0.01$). The greatest reduction of DIX and the highest yields were observed when fungicide was applied at the R1+R3 growth stages. For site-years where SSR was not present in fully-integrated trials, the main effects of row spacing ($P < 0.01$), population ($P < 0.01$), and fungicide application ($P = 0.04$) significantly influenced yield. The highest yields were observed at 197,600 seeds/A and the lowest yields at 108,000 seeds/A. In the partially-integrated site-years, the main effect of planting population ($P < 0.01$) and fungicide applications ($P = 0.04$) had a significant influence on DIX, while only planting population ($P < 0.01$) had a significant effect on yield. DIX was lowest in plots planted at 108,000 seeds/A or when fungicide was applied at the R1 and R3 growth stages. However, yield inversely followed this trend with the lowest yields observed at 108,000 seeds/A. When disease was not present in partially-integrated locations, only planting population had a significant effect on yield ($P = 0.02$). Yield was lowest when planting populations where 108,000 seeds/A. While our analysis suggests that by utilizing wider row spacing and lower planting populations can reduce disease over that of narrow row spacing, yield potential is also reduced, especially in years when weather is not favorable for SSR. However, yield potential can be balanced by dropping planting populations below 138,000 seeds/A in narrow row-spacing and reserving wide row spacing and low planting populations for extremely problematic fields.

Assessment of QoI Sensitivity and Frogeye Leaf Spot Race of *Cercospora sojina* in Georgia Soybean

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Frogeye leaf spot (FLS), caused by the fungal pathogen *Cercospora sojina* K. Hara, is a foliar disease of soybean (*Glycine max* L. (Merr.)) responsible for yield reductions throughout the major soybean producing regions in the world. To control this disease in the United States, fungicides in the class of quinone outside inhibitors (QoIs) or strobilurins are commonly applied, which has resulted in the development of fungicide resistance in many states. In 2018 and 2019, 79 isolates of *C. sojina* were recovered from six counties in Georgia and were screened for fungicide resistance using a PCR-RFLP method. Resistant isolates were confirmed in three counties by comparing the nucleotide sequences of the cytochrome *b* gene. To better understand the races of *C. sojina* present in Georgia, 40 of the isolates collected from soybean fields in Georgia were used to inoculate six soybean differential cultivars, 'Davis', 'Hood', 'Tracy', 'Lincoln', 'Lee', and 'Blackhawk.' Soybean differentials were grown on average for 14-days and then inoculated with conidial suspensions adjusted to 6×10^4 spores/mL and then re-inoculated after 24-hours. After 14-days, soybean differentials were assessed as either susceptible or resistant. Isolate reactions suggested eight different races of *C. sojina* present in Georgia, three of which have not been previously described. However, no isolates were pathogenic on differential cultivar 'Davis,' containing the *Rcs3* gene, which suggests the gene is still an effective source of resistance in Georgia.

Reduction of Pythium Damping-off in Soybean by Biocontrol Seed Treatment

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Pythium is one of the major groups of pathogens that cause disease on soybean, affecting the seedlings and causing both pre- and post-emergence damping-off and seedling root rot. More than 100 species of *Pythium* have been identified, including some that are particularly important for soybean given their aggressiveness and frequent occurrence, such as *P. irregulare, P. sylvaticum, P. ultimum* var *ultimum,* and *P. torulosum.* The harnessing of native biological control agents (BCAs) can be a very powerful tool that could be integrated with other strategies to improve disease management. *Trichoderma* spp. and *Clonostachys rosae* are necrotrophic mycoparasites that have been used for the management of plant pathogenic fungi, in addition to oomycetes, bacteria, and nematodes. This study aimed to investigate the antagonistic activity of potential BCAs against six pathogenic *Pythium* species: *P. sylvaticum, P. irregulare, P. ultimum, P. lutarium, P. torulosum,* and *P. oopapillum*. The potential BCAs tested were *T. hamatum* (WINSO2-1-16), *T. harzianum* (WMICO1-2-26 and WMICO1-1-19), and *C. rosae* (WARSO2-5-23). An *in vitro* assay using the dual plate technique demonstrated that all isolates were highly antagonistic to *Pythium* spp. with the highest growth inhibition caused by *T. hamatum* (up to 83%), followed by *T. harzianum* and *C. rosae,* respectively. Based on these promising results, these BCA isolates were tested under field conditions in Iowa and Michigan during 2016 and 2017 against all six *Pythium* species. Even though variations were observed among field-year, the overall results indicate that the BCA isolates, used alone or in different combinations, provided protection of soybean seedlings to *Pythium* species. BCA-treated plots had significantly higher stand counts and vigor compared with control plots with only the pathogen inoculum. The mixture of both *T. harzianum* isolates provided the best protection, with higher stand counts and vigor. In future research, the development of optimized delivery systems has the potential to improve the efficacy of BCAs in the field. The results presented in this research are relevant for further development of tools to incorporate biological control into soybean disease management programs.

Understanding Cercosporin Self-resistance to Identify Novel Tools to Manage Cercospora Leaf Blight on Soybean

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Management of Cercospora leaf blight (CLB), caused by *Cercospora* cf. *flagellaris*, has been a constant challenge for Louisiana soybean farmers. CLB is an end-of-season disease, with symptoms occurring during R5/R6 growth stages. Leaf symptoms include purpling, bronzing, blighting and ultimately defoliation. CLB symptoms have been associated with the production of a perylenequinone toxin, cercosporin, by the pathogen. This toxin uses light energy to generate reactive oxygen species (ROS) that damage cells and release nutrients to the fungus. Although ROS is universally toxic to cells, perelynequinone producing fungi appear to be unharmed by the toxin and ROS. This self-resistance has been explored with the aim of identifying tools to manage Cercospora diseases. One mechanism of self-resistance is the maintenance of cercosporin in a chemically reduced state inside hyphae, preventing internal ROS production. In another perylenequinone producing fungus, the toxin is sequestered inside lipid droplets (LD) preventing ROS production inside cells. It is currently unknown whether *Cercospora* spp. uses a similar mechanism to trap cercosporin in LD and resist cellular ROS generation. We used lipid assays, light and confocal microscopy to study the importance of LD in cercosporin self-resistance. Three isolates of the pathogen that produced an average of 0.125, 0.130, and 0.045M cercosporin, had 54.85, 45.85, and 40g/L average total lipids, respectively. While there was no statistically significant correlation between total lipids and cercosporin production, more sensitive assays that directly measure LD are currently underway. Light micrographs of 3-day old cultures indicated the presence of hyphae of two thicknesses, 12 µm and 21 µm. A red substance, likely cercosporin, was observed inside vesicles, particularly in thinner hyphae. The presence of different hyphae suggest a switch from biotrophic to necrotrophic lifestyle as observed in some *Colletotrichum* spp. The present model of cercosporin self-resistance suggests that only reduced cercosporin is present in hyphae and this is uniformly distributed in the cytoplasm, unassociated with cellular structures. Confirming previous studies, 1-day old cultures grown under light contained reduced cercosporin in the cytoplasm. However, hyphae also contained cercosporin, observed in vesicles, particularly in thinner hyphae. Studies with LD dyes are currently underway to clarify that vesicles are LD. If LD trap cercosporin, this could provide new possibilities to control CLB. Fungicides that inhibit lipid synthesis will be tested against *C.* cf. *flagellaris* with the final goal of translating our findings into practical CLB management.

Evaluating the Efficacy of Soybean Seed Treatment on High and Low Vigor Seed in Arkansas

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Seedling diseases are one of the major production problems for soybean (*Glycine max*), reducing plant stands and yields, especially with low vigor seeds. Chemical seed treatments are the primary control measure for seedling diseases. These treatments may contain one or more fungicides with or without an insecticide or nematicide. It is not always clear which seed treatment will be the most effective at protecting the plant from seedling disease. A study was established at the Southeast Research Station, Rohwer, AR, comparing commercial seed treatments on high and low vigor seed of an early (Show Me Soy 3901) and late maturing cultivar (UA 5715) planted on May 16th and June 15th. The seed treatments were control (treated with water), ApronMaxx (fludioxonil + mefenoxam), Cruiser (thiamethoxam), CruiserMaxx Vibrance Beans (thiamethoxam + mefenoxam + fludioxonil + sedaxane), Avicta Complete Beans (abamectin + thiamethoxam + mefenoxam + fludioxonil), Maxim (fludioxonil), Vibrance (sedaxane), EverGol Energy (prothioconazole + penflufen + metalaxyl), Trilex (trifloxystrobin), and Allegiance (metalaxyl). Low vigor seed was created by exposing the high vigor seed to a chamber with high temperature and moisture. The experimental design was split plot with the cultivar as the main plot. Stands were assessed four weeks after planting, and yields taken at the end of the season. Germination and accelerated aging of all the treatments were determined. Analysis of variance and mean separations were determined using PROC GLIMMIX (SAS *Institute Inc*., Cary, NC). Results found significant three-way interactions between seed treatment, seed quality, and planting dates for plant stands and yields with both cultivars. In general, plant stands were greater in the June than the May planting and yields were greater in May than June for both cultivars. Significant increases in stands and yields with some seed treatments were observed with low vigor seeds, especially with UA 5715. Significantly lower stands and yields than the control occurred with low vigor seed of Show Me Soy 3901 with some seed treatments. Compared to the control, there were significant increases in standard seed germination and accelerated aging with some seed treatments, but significant reductions with other seed treatments.

Impact of Wheat on Soybean Cyst Nematode (*Heterodera glycines* I.) Populations in a Soybean Double Cropping System

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Double cropping (DC) is defined as producing more than one crop on the same parcel of land in a single growing season and has many benefits to soil and cropping systems. In soybean production, the crop is often planted following the harvest of winter wheat. This practice is common in the lower Midwest and southern U.S. In Illinois, DC is more successful in the central and southern parts of the state due to earlier wheat harvest and warmer weather in the fall, allowing winter crops to grow for a longer time before the occurrence of frosting temperatures.

The soybean cyst nematode (SCN) (*Heterodera glycines* Ichinohe) is a major biotic cause of yield losses in soybean. It is widely distributed in all major soybean production areas of the US. In Illinois, SCN is present in more than 80% of soybean production fields, and it can cause up to 30% of yield loss without showing noticeable aboveground symptoms. To reduce losses, several management practices are recommended, including using resistant varieties, non-host, crop rotation, the use of seed-applied nematicides, biological control, weed management and other principles of integrated pest management (IPM). Several research reports indicate possible suppressive effects of wheat on SCN populations in soybean DC systems. Knowing that growers use DC soybeans in Illinois and increasing temperatures could allow producers to practice DC in higher latitudes, an experiment was conducted to assess the effect of wheat production on SCN population densities.

Fields were planted with wheat in fall 2017, harvested in June 2018 and soybean was planted after wheat. Nine fields with 3 levels of initial SCN populations (low, moderate, and high) were planted in strips with winter wheat alternating with strips maintained in fallow and were followed by soybeans after wheat harvest. SCN population count was assessed 4 times: pre-wheat planting, after-wheat/pre-soybeans, mid-soybeans (R1) and after-soybeans. There was a significant effect of wheat on reducing SCN populations on soybeans at R1 and after harvest. Results show that all initial populations had reduced egg count after harvest on DC fields compared to non-wheat. Environmental factors and the possible effect of wheat root exudates and mechanical interference are indicated as possible causes of reduced SCN populations where wheat precedes soybeans. Future work will study the effect of wheat on the soil microbial community using metagenomics tools to identify key microorganisms affecting SCN in the soil. DC has the potential to improve soil health, suppress SCN and soil-borne pathogen populations, and it is a good system to provide additional farm income while conserving soil health.

Using Unmanned Aerial Systems and Multispectral Imagery to Assess Sudden Death syndrome of Soybean

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Recent advances in optical multispectral imaging make remote sensing a promising and attractive alternative to traditional crop disease detection. Based on a range of sensors and platforms, such as handheld spectroradiometer systems, Unmanned Aerial Systems (UAS), aircrafts and satellites imaging systems, remote sensing can capture unique spectral signatures of leaf canopy in response to different infection levels associated with particular pathogens on a wide range of scales. However, there is a general paucity of research regarding the combined use of such tools to monitor Sudden death syndrome (SDS) and other soybean diseases.

SDS, a soilborne disease caused by the pathogen *Fusarium virguliforme*, was the target disease for the imagery workflow and model development in this study. The pathogen infects the roots soon after planting and produces a toxin that is translocated to the foliage. The expression of foliar symptoms is usually in the reproductive stages of a soybean plant. The most evident symptomology is interveinal chlorosis and subsequent necrosis in the trifoliate leaves. These symptoms can lead to dramatic losses in soybean yield. In addition, root infection and rotting caused by the pathogen can lead to yield losses in the absence of foliar symptoms. Therefore, this disease is an excellent candidate for applying remote sensing to detect the variable severity of symptoms in a field.

Field trials were conducted in 2018 and 2019 in a field in Valmeyer, IL with a 30-year history of SDS. Trials were planted in April of each year. Treatments included various rates and combinations of adepidyn with base fungicides in comparison to treatments with fluopyram. Both of these compounds are effective against *F. virguliforme*, and reduce the incidence and severity of SDS. Treatments in both years were paired with a base fungicide check, and all treatments were replicated 5 times. Foliar ratings of disease incidence and severity were recorded weekly after symptom expression. Imagery was collected with RGB and Multispectral cameras mounted on a UAS on the same dates when plots were manually rated on the ground. Zonal statistics and various vegetation indices were calculated in the GIS software. The vegetation indices with the best agreement with SDS ratings on the ground were selected as potential indicators to detect SDS. The results show a strong relationship between NDVI values and SDS foliar ratings (R^2=0.7241, $P < 0.0001$).

Soybean rust – Scourge of Alabama

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Soybean rust (SBR) was the most common disease of soybean in Alabama during 2019. The disease was found in 43 of the 67 counties by September 20th (Figure 1). This compares to only 13 counties reporting the disease at the same point in time during 2018. With soybean plantings delayed in some areas due to wet weather in the spring, and fewer growers spraying fungicides due to the depressed price of soybeans, we feared that SBR could be a significant problem on late maturing soybeans in the state.

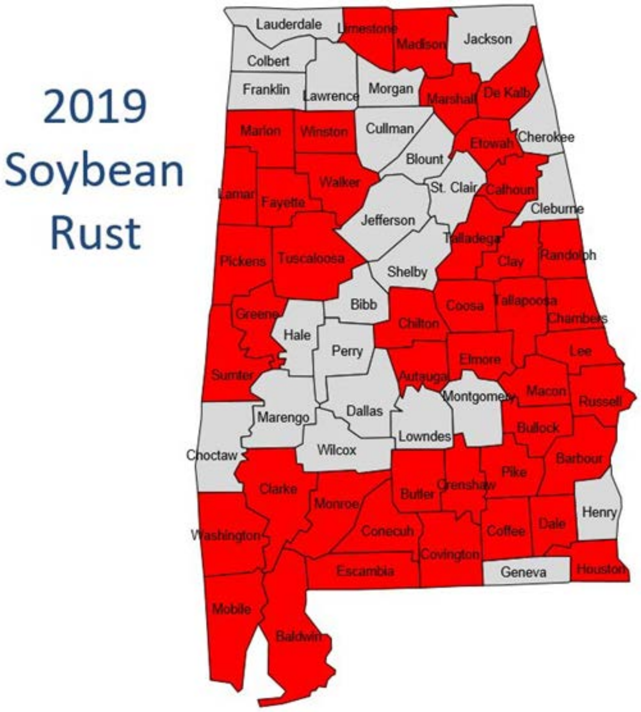

Figure 1. Distribution of soybean rust in Alabama during 2019.

Conditions were favorable for SBR activity due to the mild winter that allowed the pathogen to overwinter on kudzu quite readily in Florida, Georgia, Louisiana, and Alabama. SBR successfully overwintered on kudzu in more counties in the southeastern U.S. than in any other year since 2005. We anticipated an increase in SBR inoculum on kudzu in South Alabama because of the spring conditions and the potential for a significant out-break of SBR because of the delayed planting of soybeans in 2019. Similar patterns were observed in 2012 and 2013 when significant yield loss from the disease was observed in commercial fields not protected with timely fungicide applications.

However, as is typically the case in Alabama, above-average summer temperatures and extremely dry conditions (mid-July through October) slowed disease progress through the state. County reports of SBR did not begin to pick up until late August in south Alabama, but by mid-September the disease could be found in most counties in the state (Figure 1). Concern grew when we noted a number of commercial fields in North Alabama that were still in early reproductive growth stages at a time when SBR inoculum was at high level in the area. However, only a few commercial fields appeared to suffer yield loss from SBR most likely due to a fungicide application as either part of their management program or in response to "SBR Alerts" sent out by the Alabama Cooperative Extension System in response to the risk determined from scouting.

One observation that caught our attention was that of the 11 fungicide trials set out across the state, only one exhibited significant disease pressure (SBR). This was a large-scale field trial at the Plant Breeding Unit of the E. V. Smith Research Center in Shorter, AL. What possibly set this test apart from other trials was that it received center pivot irrigation 12 times during the growing season. We suspect the late planting of the test (June 20th) together with consistent watering favored the development of SBR. It has been reported that other diseases such as SDS, white mold and some foliar diseases may increase if soybeans receive too much water, particularly early in the growing season. However, the effects of many soybean diseases are abated because irrigated plants are healthier and yield well.

The large-scale replicated fungicide trial at Shorter included three fungicide treatments and a non-treated. Treatments included single applications of Acropolis @ 23 oz., Trivapro @ 20.7 oz., and Quadris Top SBX @ 7.5 oz. (plus NIS). Fungicides were applied on September 30th at the R3-4 growth stage. Results showed a benefit of a single fungicide application in controlling SBR with a significant increase in yield and decrease in disease severity versus the non-treated (Table 1).

Table 1. Results from a fungicide trial conducted in Shorter, AL to manage soybean rust during 2019.

		Soybean rust (0-8 scale)			
Fungicide rate (fl oz/A)	**FRAC code**	**9/26**	**10/3**	**Yield (bu/A)**	**% increase in yield**
Non-treated	-----	4.4 a	7.5 a	77.0 b	---
Acropolis 23 fl oz	1, 3	0.0 c	0.3 c	95.9 a	24.5
TrivaPro 20.7 fl oz	3, 7, 11	0.3 c	1.1 bc	92.7 a	20.4
Quadris Top 7.5 fl oz	3, 7	1.8 b	1.7 b	85.5 ab	11.0

*Means followed by same letter do not significantly differ (*P*=0.10, Duncan's New MRT). The experiment was planted on June 20th and irrigated 12 times with 0.5" water between June 27 and September 25th.

Management of SCN and SDS with Nematode-protectant Seed Treatments Across Multiple Environments

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Soybean cyst nematode (SCN) management has proved challenging with limited host resistance available in most commercial soybean varieties and the long-term survival of viable eggs within cysts in the soil. Nematode-protectant seed treatments have become an emerging tool available marketed for the management of nematodes, including SCN. Additionally, with a known interaction between SCN and the sudden death syndrome (SDS) pathogen, *Fusarium virguliforme*, the utilization of nematode-protectant seed treatments for the control of SCN may impact the severity of SDS foliar symptoms and root rotting. The objectives of this study were to: i) test the efficacy of SCN seed treatments across environments; ii) assess SCN seed treatments for their effects on SDS foliar symptoms; and iii) evaluate SDS root disease severity.

Small plot trials were established in six U.S. states (IA, IL, IN, MI, MO, and WI) and one Canadian province to test the efficacy of five nematode-protectant seed treatment products as compared to a generic base fungicide + insecticide or naked seed. The same soybean variety with the PI 88788 source of resistance was planted at all locations with the exception of Missouri which utilized another soybean variety with the PI 88788 source of resistance of later maturity. All seed was sourced from the same seed lot and seed treatments were commercially applied to seed. Seed treatments included: a generic fungicide (Allegiance, Stamina, Systiva XS) + insecticide (Gaucho 600) base, BioST + base, Aveo + base, Nemastrike + base, Clariva + base, and Ilevo + base.

To evaluate the SCN efficacy of the aforementioned seed treatments, soil samples were collected from each plot at planting and following harvest to assess nematode populations, a SCN reproductive factor was calculated (final SCN population divided by initial SCN population), and females were collected and counted from the roots of five random plants in each plot after 30 days of growth. SDS foliar disease symptoms were assessed in each plot beginning at symptom development and continuing for three weeks. In addition, roots were evaluated for symptoms of SDS root rot at the R5 growth stage. Yield data were collected from each plot and was analyzed for differences among treatments.

Initial SCN population densities in the soil ranged from 23 to 11,700 SCN eggs per 100cc of soil. Significant differences were only detected among treatments for the number of females recovered from roots after 30 days at two locations and for SDS foliar disease levels at R5 at one location. At two locations, significant differences were observed among treatments for soybean yield with the naked seed control yielding lowest at both locations. When the data were combined across all locations, significant differences were not detected for 30-day SCN female counts, SCN reproductive factor, SDS foliar disease symptoms, SDS root rot, or yield. Overall, the effects of nematode-protectant seed treatments on SCN reproduction, SDS disease symptoms, and soybean yield were inconsistent across environments.

Determining Inoculum Density of *Xylaria* sp., the Taproot Decline Pathogen, in Soil Under Various Crop Rotation Systems

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In soybean, *Xylaria sp.*, the causal agent of taproot decline, causes a breakdown of the taproot, which in turn becomes dry and brittle. The breakdown of that taproot promotes a general chlorosis of the older leaves, and as the disease progresses, an interveinal chlorosis becomes apparent. Previous research in our laboratory has shown that *Xylaria* sp. is not host-specific to soybean but also infects other important agronomic crops in greenhouse studies. This result is concerning as crop rotation is a standard practice for improving soil health and disease management in soybean. This study focuses on the effect that continuous soybean and rotational crops have on the inoculum density of *Xylaria* sp. in the soil. Greenhouse studies were established to resemble a four-rotation planting cycle (12-wk) using corn, cotton, and wheat, each in rotation with soybean. A *Xylaria* sp. primer was designed and a plasmid standard curve was determined to quantify inoculum density based on the absolute number of DNA copies. Prior to planting the initial rotation, MS Delta soil was sterilized and infested with 1.5 g *Xylaria* sp.-infested corn cob grit. Soil cores were removed 7-d post inoculation/planting to establish the baseline inoculum density. At 12-wk, plants were removed at the soil line leaving the root material intact as substrate for *Xylaria* sp. Soil samples were taken and the following rotation was planted. The experiment was repeated: Exp. A was initiated June 14th and Exp. B was initiated a week later. For each experiment, the first and second planting of a four-rotation cycle has been completed. DNA was extracted from 12-wk and 24-wk soil samples and prepared for qPCR amplification. As expected, following 12-wk, *Xylaria* sp. DNA copies increased in the presence of soybean root. At 24-wk, in soybean and cotton rotations, inoculum density of *Xylaria* sp. decreased, which may be due to a lack of root system as the soybean and cotton plants did not fully develop due to infection. After 24-wk, corn and wheat in rotation with soybean, appear to maintain *Xylaria* sp. inoculum density in the soil. This may be due to host preference by the fungus or due to the fibrous root system of these crops providing more surface area for *Xylaria* sp. colonization. In conclusion, regardless of crop rotation, *Xylaria* sp. inoculum is persisting in the soil. Up-to-date results following the third rotation planting cycle will also be presented.

A New Pathosystem to Study the Plant-fungal Interactions Underlying Cercospora Leaf Blight of Soybean

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Cercospora leaf blight (CLB) is a detrimental soybean disease caused by plant pathogenic fungi in the genus *Cercospora*. Historically, *Cercospora kikuchii* was considered to be the primary causal agent of CLB, but other *Cercospora* spp. have recently been associated with the disease. In particular, *Cercospora* cf. *flagellaris* seems to have displaced *C. kikuchii* as the primary causal agent of CLB in the U.S. *C*. cf. *flagellaris* appears to have a broad host range and is hypothesized to generate genetic diversity via inter- or intra-specific hybridization. However, little is known about the genetic basis of pathogenesis in *C*. cf. *flagellaris*. A key bottleneck for CLB research is that disease symptoms are difficult to reproduce in greenhouse and growth chamber conditions. The goal of this study was to develop a *C.* cf. *flagellaris* - *Arabidopsis thaliana* pathosystem as a proxy for CLB of soybean. We determined that the *C*. cf. *flagellaris* wild type strain ARCK7—which was first isolated from soybean leaves affected by CLB—readily infected *A. thaliana.* Symptoms on *A. thaliana* consistently appeared six to seven days after inoculation, which is consistent with reports of latent infection in soybean. Symptoms included necrotic lesions and premature leaf abscission, although foliar bronzing/purpling was not observed. Approximately ten days after inoculation, ARCK7 produced conidia abundantly from mature lesions on leaves of *A. thaliana*. To determine if the ability to infect *A. thaliana* was strain-specific, eighteen additional strains of *C*. cf. *flagellaris* isolated from soybean were evaluated and confirmed to infect *A. thaliana*. Experimental conditions including spore concentration, inoculation technique, temperature, light, and humidity were optimized for consistent, reliable infection. The ability of *C.* cf. *flagellaris* strains associated with CLB to infect *A. thaliana* suggests a broad host range for the pathogen, which is an important consideration for disease epidemiology and control. Additionally, the utilization of *A. thaliana* as a proxy for soybean has numerous advantages for discovering/engineering novel resistance genes and advancing the fundamental understanding of molecular mechanisms underpinning CLB.

Impact of Cultivar on Soybean Foliar and Seed Diseases in Arkansas

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In 2018, Arkansas soybean growers experienced high levels of visual seed damage that led to significant penalties at the grain elevator. That year, high levels of damaged seed were observed in a regional Cercospora leaf blight cultivar test planted at Marianna and Kibler, AR. Besides rating these tests for foliar disease, seed samples were collected from each plot and assayed for visual seed damage and seed infection. The tests consisted of 45 soybean cultivars ranging in maturity from maturity group 4.1 to 5.7. The cultivars were planted in two row plots, 6.4 m long in a randomized block design with four replications on 14 June and 22 June and harvested on 13 October and 15 November at Marianna and Kibler, respectively. Visual damage was assessed on 140 seeds from each plot. The percentage of seed with purple, brown, or chalky appearance was determined. In addition, 50 seeds from each plot were surface disinfested by soaking in 70% ethanol for 1 min, and plated on acidified potato dextrose agar (PDA). Plates were incubated at room temperature and light for seven days. The percentages of seed infected by *Phomopsis longicolla*, *Cercospora kikuchii*, and other fungi were determined. Identification was based on colony morphology. At Marianna, the total damaged seed (purple + brown + chalky) ranged from 2 to 12%, and purple seed ranged from 0 to 8%. Seed infection by *P. longicolla* ranged from 9 to 76% and by *C. kikuchii* from 2 to 37%. Seed infection by *C. kikuchii* was not significantly correlated to the percent purple seed or total damaged seed. *Phomopsis longicolla* was significantly correlated to both purple seed and total damaged seed (0.2083, *P*=0.005, and 0.1925, *P*=0.0096, respectively). At Kibler, the total damaged seed ranged from 1 to 20%, and purple seed ranged from 0 to 11%. Seed infection by *P. longicolla* ranged from 0 to 46% and by *C. kikuchii* from 3 to 41%. Seed infection by *C. kikuchii* was significantly correlated to percent purple seed (0.7983, *P*<0.0001), to total damaged seed (0.78092, *P*<0.0001) and to percent *P. longicolla* (0.52364, *P*<0.0001). *Phomopsis longicolla* was significantly correlated to both purple seed and total damaged seed (0.3991, *P*<0.0001, and 0.4312, *P*<0.0001, respectively). Total percentages of damaged seed, purple seed, seed infected by *P. longicolla*, and seed infected by *C. kikuchii* were greater in early than late maturity group cultivars. At Marianna, Cercospora leaf blight ranged from 0 to 2.5% and target spot from 0 to 9%. At Kibler, Cercospora leaf blight ranged from 0 to 2%. Target spot was not rated. Cercospora leaf blight was not significantly correlated to the percent of purple seed or seed infection by *C. kikuchii*. Overall, most cultivars had low levels of visual seed damage and infection by either pathogen at each site. A few showed differential responses being high at one location and low at the other.

Thoughts on Southern Blight: Should We be Concerned about Southern Blight?

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Recently, observations of southern blight, caused by *Athelia rolfsii* (syn. *Sclerotium rolfsii*), have increased in Mississippi. Prior to 2017, southern blight was most regularly observed shortly after emergence. Symptoms associated with the disease generally include wilting and sometimes seedling death in planted rows between V2 and V5. However, since 2017 southern blight symptoms have been regularly observed on plants in reproductive growth stages (R3-R7) and included interveinal chlorosis, wilting, defoliation, and plant death in severe instances. In general, southern blight symptoms can be easily confused with several important stem diseases including stem canker, charcoal rot, and Phytophthora root rot, and therefore in-field diagnosis is important and should encompass plant-associated symptoms at numerous growth stages as well as the observation of signs. The signs of southern blight help discriminate the disease from other root and stem-associated diseases. Southern blight signs include the production of white mycelia at the base of the plant in addition to the production of sclerotia which serve as the overwintering structure. Plants observed expressing the symptoms associated with southern blight should be carefully observed for signs by unearthing plants and looking for mycelia as well as sclerotia on roots below the soil surface. Management strategies to reduce the potential of yield losses associated with southern blight would include: Rotation to a non-host crop, deep tillage to bury residue, planting of resistant varieties, and not planting soybean following peanut. Potential differences between commercially available varieties are have not been previously investigated.

During 2018 and 2019, observations of southern blight were made in the Mississippi State University Official Variety Testing (OVT) program. OVTs are planted in multiple soil classes to capture the most meaningful performance data on commercial offerings and contain Conventional, Enlist, LibertyLink, RoundUp Ready, and Xtend varieties. Eight distinct locations contained separate OVTs, with the Stoneville location containing three OVT sets (two irrigated (clay, loam), and one non-irrigated (clay)). The previous crop differed by location, but consisted of corn (n=5), cotton (n=2), peanut (n=1), rice (n=2), soybean (n=10), and wheat (n=2) for each of the 22 locations. In all, 341 entries were observed with 305 as unique entries. Evaluations were made between R6 and R7 depending on location and attempted to capture the occurrence of southern blight by considering symptoms on foliage as well as the presentation of signs on the crown of soybean plants. In general, observations were made using a 0-9 scale and considered an evaluation whereby 0=no southern blight, 1=disease present, 5=approximately half of the plants in the plot expressing symptoms and/or signs, and a 9=severe southern blight in all plants based on wilted plants, severe defoliation and presence of mycelia and sclerotia on the base of plants.

Observations of southern blight in individual varieties based on the 0-9 scale ranged from < 1 to > 8. When averaged across locations within each year evaluations ranged from less than 1 to 7. In 2018, approximately 35% of the varieties were between a 2 and a 3, with approximately 37% between a 2 and a 3 during 2019. Even though a limited number of entries presented more severe symptoms this suggests major differences in sensitivity exist between varieties.

From Plots to Strips: Six years of fungicide trials

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From 2014-2019, 27 foliar fungicide trials were completed in southeastern Arkansas on soybean. Funding for these trials was provided by the Arkansas Soybean Promotion Board in two separate three-year grants. In the first three seasons, 14 trials were arranged in a randomized complete block design with plots a minimum of 10 ft (3 m) long, 4-rows wide, planted on raised beds 38 in (96.52 cm) apart, and with a minimum of three replications near Rohwer, AR. Foliar fungicides were applied in either 10 or 15 gal (37.85 - 56.78 liters) of spray volume (depending on the trial), with an untreated control in each trial, using a ground driven sprayer with a research multi-boom. Applications were made at approximate timings targeted to pods 3/16 in (0.47cm) long at one of the four uppermost nodes on the mainstem with a fully developed leaf (R3), pods ¾ in (1.91 cm) long at one of the four uppermost nodes on the mainstem with a fully developed leaf (R4), or seed 1/8 inch (0.32 cm) long in a pod at one of the four uppermost nodes on the mainstem with a fully developed leaf (R5). Each trial was harvested with a plot combine and moisture adjusted to 13.0%. Foliar disease levels were rated for each plot, 14 and 28 days after application. In all tests, data were subjected to analysis of variance (ANOVA) followed by means separation of fixed effects using Fisher's protected least significant difference (LSD) P=0.10. Foliar fungicides suppressed frogeye leaf spot (*Cercospora sojina*) where significant disease was present. Yields averaged 54 bushel/acre (3.63 t/ha) across all tests, ranging from 47 – 73 bushel/acre (3.16 – 4.9 t/ha), and were only significantly different from the untreated control in one of the trials. Because questions were raised as to the relatability of small plot replicated trials to the more "real-world" conditions of commercial fields, largely due to the spatial variability of foliar diseases in a small station field of approximately 10 acres (4.04 ha), the objective of the second project, during 2017-2019, was to test products in larger plots or strips and incorporate sub-field spatial analysis along with whole field analyses. Foliar fungicides were applied at 10-gal (37.85 liters) of spray volume using a ground driven sprayer with a 30 ft (9.14 m) boom at 40 psi (275.8 kPa). Trial sizes ranged from 8-42 acres (3.23 – 16.99 ha), with treatment pots one sprayer width wide with three replicates. Trials were located on farms in Ashley, Lincoln, Desha, and Chicot counties. Thirteen trials were completed, and georeferenced yield data was provided from a yield monitor on each farmer's combine. Yield was buffered, cleaned, and moisture adjusted to 13.0%. Foliar disease levels were rated at 10 fixed points per plot, at disease onset and then 14 to 28 days later until maturity. In all tests, data were subjected to ANOVA followed by means separation of fixed effects using Fisher's protected least significant difference (LSD) P=0.10. Yields averaged 62.3 bushel/acre (4.18 t/ha) across all tests, ranging from 33 – 86 bushel/acre (2.21 – 5.78 t/ha), and were significantly different in three of the trials using whole-field analysis. Of those three, the treatments significantly increased yield above the untreated control one time. In sub-field analyses, efficacy of foliar fungicides varied by location and within zones of foliar disease incidence and severity. The larger strip plots enabled products to be tested within zones of disease severity. This method took advantage of the spatial variability of foliar diseases like frogeye leaf spot, target spot (*Corynespora cassiicola*), and Cercospora leaf blight (*Cercospora* spp.).

Meta-analysis of Soybean Yield Response to Foliar Fungicides Evaluated from 2005 to 2018 in the United States and Canada

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Meta-analyses were performed on data from 239 field trials conducted over 13 years between 2005 and 2018 across nine U.S. states and Ontario, Canada, to quantify the yield response of soybean following application of foliar fungicides at the R3 soybean growth stage. The analysis also quantified whether certain fungicide groups behaved differently and how weather conditions during the season and location influenced yield responses. Meta-analysis of individual trials data showed that the overall mean yield response for fungicide application compared to non-treated control was 105 kg/ha (a 2.6% yield increase). Nine moderator variables including fungicide class, growing season, trial location, planting date, weather variables and base yield were used to further explain the yield gains. All tested moderator variables significantly influenced the yield response except trial location. Fungicides containing multiple modes of action including QoI increased the yield response to 152 kg/ha (a 3.5% increase) compared to single modes of action. The greatest yield responses to foliar fungicides occurred when soybeans were planted early and when total precipitation between planting and the R3 application date was above historic averages (a 3.0% increase). Warmer temperature during the season also provided greater yield response (a 3% increase) when foliar fungicide was used. Baseline yield (mean yield in non-treated plot) significantly influenced the yield response with greater yield difference in normal than that in highest and lowest yield categories. The probability of getting return on fungicide application cost was estimated on a range of grain price and application cost combinations. The low probability of covering fungicide cost in most scenarios suggest that the use of foliar fungicides is less likely to be profitable when foliar disease is absent or at low level.

On the road in Louisiana: Taking the research station to farms

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Many foliar diseases of soybean occur in Louisiana on an annual basis. Cercospora leaf blight (CLB), frogeye leaf spot, and aerial blight are among the most prevalent foliar diseases in the state causing significant yield losses. Widespread use of QoI fungicides since the early 2000s has resulted in resistance in all three of these pathogen populations. Other diseases of note that occur annually are target spot and pod and stem blight.

QoI resistance conferred by the F129L mutation in *Rhizoctonia solani*, causal agent of aerial blight (soybean) and sheath blight (rice), has become common in areas that practice soybean/rice/crawfish rotations. The current distribution of QoI resistance is not well-defined, and it is a challenge for producers to manage these diseases in southern Louisiana. Sclerotia produced by the pathogen are ubiquitous in these production systems and supply never-ending inoculum. Most growers in these areas drill beans (narrow rows) in zero-grade fields, and once canopies overlap, which can occur as early as V stages, disease can begin. Hot, humid environments along with frequent rainfall persist throughout the growing season resulting in prime conditions for aerial blight development in soybean. Yield losses due to aerial blight can be catastrophic if left unchecked.

Developing management strategies for QoI-resistant aerial blight is a challenge for researchers because the condition is not known to exist on research stations. Therefore, trials must be conducted on farms where QoI resistance has been confirmed through laboratory diagnostics or field failures. Conducting on-farm research produces a unique set of challenges. Close cooperation with farmers, parish agents, industry, and other scientists is key to completing a successful trial. Careful planning, specialized spraying equipment, GPS, and aerial imagery will optimize operations. However, due to Murphy’s Law, patience and persistence is key.

In recent years in Louisiana, we have had successes implementing large and small plot trials on farms. We have evaluated fungicides for their efficacy on Cercospora leaf blight, pod and stem blight, QoI-resistant aerial blight, and target spot along with yield preservation. We have also evaluated the effect of fungicides under minimal disease pressure. Extending our efforts outside of the research station has been a challenging yet very rewarding and productive venture. Continuing to develop relationships with our growers not only helps us solve “real-world” problems for them but provides a wealth of perspective and fresh ideas.

The Next Super Model: Development of a Flexible Framework for Multiple Disease Models in Soybean

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Many plant disease prediction models have been developed over the years. However, adoption of these prediction models for use in the field has been slow at the farm level. Several reasons for this exist. First, these models often rely on several or many weather variables that must be measured with a high level of accuracy and precision. Just 20 years ago, weather networks were generally not capable of providing weather information at a level to provide inputs for accurate, on-farm prediction. For instance, weather information may have been delivered from weather stations at airports, where the geography is much different than an agronomic field. In the 21st century, the ability to provide site-specific accurate weather information for agronomic fields has improved drastically allowing for high quality inputs for disease prediction models not previously available.

The second reason that plant disease prediction systems have not been widely adopted is that the models are often complicated and developed around predicting pathogen-specific dependent variables such as the number of spores, or a non-descriptive risk index. These types of systems can be complicated, cumbersome, and meaningless to clientele who are trying to actively manage plant diseases. Recently plant disease epidemiologists have borrowed techniques such as logistic regression from human epidemiologists in order to simplify disease prediction to probability estimates. In our research and extension program, we have found that growers and crop consultants embrace the idea of probability of disease risk. This type of disease prediction output is analogous to weather prediction and plant disease managers are comfortable with this concept. By using this approach and coupling it with accurate weather information, the quality of plant disease prediction has dramatically increased. We have further augmented the usability of these improved disease prediction systems by automating them in smartphone applications (our main smartphone application is Sporecaster, used for prediction of Sclerotinia stem rot of soybean). Our own research on Sclerotinia disease prediction systems has revealed that pest management professionals find these types of systems useful and valuable as they implement sustainable plant disease management plans.

The framework is now in place to generate multiple disease prediction systems for soybean. Past disease data, or newly generated data, can be used to re-train the framework for any soybean disease of interest. These predictions can then be integrated into existing smartphone applications to help farmers make decision on in-season disease management across the soybean production belt.

IPM Implementation in Tennessee

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Part of the requirement of receiving a USDA-NIFA Crop Protection and Pest Management grant in the Extension Implementation Program Area (CPPM-EIP) is to present on the projects within the proposal. The University of Tennessee CPPM-EIP addresses the priority areas of IPM Implementation in Agronomic Crops, IPM Education for Pesticide Applicators, IPM Training and Implementation in Housing, and IPM Training and Implementation in Schools. The Project Director and all co-PDs are all within the Institute of Agriculture and include Extension Specialists in plant pathology, (field crops and urban) entomology, weed science, agronomy, and the pesticide safety education coordinator. Our goal is to provide stakeholders with the knowledge to make IPM recommendations and decisions that are effective, economically viable, and environmentally sustainable. The proposed activities are primarily designed to disseminate knowledge and improve adoption of IPM practices in agronomic crops, residential housing units, and schools. Specific objectives address developing online resources, intensive training of agricultural county agents, the monitoring and management of invasive and pesticide resistant pests, education of private and commercial pesticide applicators, and training for IPM decision makers in public or low-income housing facilities and in schools. These objectives support the CPPM goals of improving cost-benefit ratios, reducing health risks, and minimizing adverse environmental effects caused by pests and IPM management practices. The specific activities completed to achieve these objectives will be presented.

Reproduction Potential and Survival of Soybean Nematodes in Row Rice

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Furrow irrigated rice or 'row rice' production has increased over the past few year in the mid-south. In Arkansas acreage increased from 40,000 in 2017 to 100,000 acres in 2018. There is limited information on the host suitability of hybrid rice to the southern root-knot nematode, *Meloidogyne incognita,* and how this new production practice may impact soybean production. Ten hybrid rice cultivars were evaluated for host suitability to *M. in*cognita in two greenhouse pot experiments. All of the rice hybrids were a suitable host for the southern root-knot nematode with a reproduction factor (RF = Pf/Pi) that ranged from 7.5 to 13.5 and averaged 9.7. These values were similar to that of popular commercial grown cultivars, CL 153 and Diamond. Five row rice fields were sampled for soybean nematodes after harvest. Three soil samples were collected from the root zone at the high and low ends of each field. More plant-parasitic nematodes were recovered from soil samples on the high end of field compared to the low end. The high end often dries out while the low end remains flooded, which suppress nematode reproduction. Southern root-knot nematode was recovered at low population density on the high end of one field, which indicates survival on a susceptible host crop when conditions are suitable for reproduction. Thus, there is a greater potential to maintain a population density of southern root-knot nematode in row rice compared to levee rice that may impact the subsequent soybean crop.

Initial Research with Peracetic Acid as a Disease Management Tool in Soybeans and Other Legume Crops

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Peracetic Acid (PAA) based formulations have unique broad spectrum Bactericidal and Fungicidal properties. Research with PAA as an anti-microbial has been primarily focused in sanitation and food safety industries. However, in crop protection, limited field studies available have shown its potential in controlling certain Bacterial and Fungal diseases of both food and non-food crops. PAA's broad spectrum activity, organic approval and compatibility with other pesticides may allow it to fit easily into the crop IPM programs. Research conducted with PAA in the last few years in Legumes such as Dry Beans have shown interesting results in bacterial disease control such as Common Blight and Halo Blight. Early research in Soybeans show potential for control of certain fungal diseases such as Frog Eye Leaf Spot. Objective of this paper is to discuss in length PAA chemistry and it's potential applications in Legumes including Soybeans as a disease control and resistance management tool.

Extension Efforts in Disseminating Nematode Survey Results

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Parasitic nematodes cause yield loss in crops, with some contributing to co-infections which can be even more detrimental to their host plants. Twelve species are of particular economic importance to crops: Soybean cyst (*Heterodera glycines*), dagger (*Xiphinema americanum*), lance (*Hoplolaimus galeatus*), lesion (*Pratylenchus* spp.), ring (*Bursaphelenchus cocophilus*), reniform (*Rotylenchulus reniformis*), spiral (*Helicotylenchus* spp.), sting (*Belonolaimus* spp.), stubby (*Paratrichodorus* spp.), stunt (*Tylenchorhynchus claytoni*), root knot (*Meloidogyne*), and needle (*Longidorus elongatus*). Since 2017, a soil sampling survey has been funded by the Tennessee Soybean Promotion Board to screen field soil submitted to the West Tennessee Research and Education Center (WTREC) at no cost to Tennessee-based farmers. To date, we have received samples from counties spanning Tennessee and Kentucky over 3 years. Each sample is screened for parasitic nematodes with number of eggs and J2 reported for soybean cyst nematodes and number of J2 only reported for the remaining 11 species. Results from samples are communicated by email to the submitter as well as their University of Tennessee Extension agent for Tennessee submissions. Included with the resulting data are management strategies tailored to the thresholds of nematode species present in individual samples. These management options encompass continued monitoring, crop rotation, resistant cultivars, and nematicides as applicable. Annual population and threshold data are compiled and disseminated through the UTCrops Extension website (UTCrops.com) and county meetings. Approaching the 2020 sampling season, evaluation of these data distribution techniques will be discussed so that improvements can be made.

Assessing the Role of Weathering on the Grain Quality of Soybean Cultivars in the Mississippi Delta

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Soybean grain quality continues to be an important post-harvest issue in Mississippi. During years when environmental conditions preceding physiological maturity (R8) include extended periods of hot, wet weather, grain quality reductions can occur when farmers transport harvested soybeans to the local elevator. Even though there are several categories that encompass grain quality as a whole, plant pathogens can significantly reduce grain quality when the environment remains conducive for extended periods of time. Numerous organisms are reportedly involved in grain quality reductions. However, *Phomopsis longicolla* remains one of the most notable fungi involved causing Phomopsis seed decay. In addition, color differences in harvested grain can lead to additional reductions in grain quality at the elevator. Several different species of *Cercospora* can result in purple seed stain that can also impact the final soybean grade assessed at the elevator and can result in a reduced grade that generally results in an economic discount.

During 2019 one Official Variety Testing location in Stoneville, MS was evaluated for the presence of grain quality issues over differing time periods. In all, 144 separate commercial entries representing maturity group (MG) IV and V sets including Enlist, RoundUp Ready, and Xtend-trait containing soybean cultivars were evaluated. The initial harvest of the location by the variety testing group was made on the MG IV early Xtend entries on September 19 with the remainder of the entries harvested on October 3. To evaluate the grain from entries, one row of each four-row plot was harvested on each of two separate dates with a one-row plot combine. Grain samples were captured and evaluations were made on the purple stained seed and grain exhibiting Phomopsis seed decay based on kernel morphology. In addition, an overall "damage" category considered all of the differences between healthy and damaged grain based on additional kernel discoloration. All evaluations were made using a 0-10 scale. The first quality evaluations occurred on October 3, 14 days after the initial harvest of the MG IV early Xtend cultivars. The remainder of the MG sets (IV late, IV Enlist, V early Xtend, and V Enlist) were harvested immediately following the variety testing harvest on either October 3 or 4. The second evaluation date occurred on November 6 (48 days or 34 days following the outlined harvest dates) for all entries considered.

The delayed harvest allowed weather conditions to increase damage and make for better evaluations. Accumulated rainfall between the first harvest date (9/19) and the final quality observations in November was greater than 10 inches. However, between 9/19 and the first quality observations on 10/3, the site had received only 0.15 inches of rain. In general, there were differences in the grain quality observations between the cultivars planted. Grain quality, as either Purple seed stain, Phomopsis seed decay or damage, decreased between the two observation periods regardless of cultivar classification (based on MG). In general, purple seed stain increased between 29 and 59%, Phomopsis seed decay increased between 81 and 91% and total damage increased between 52 and 60% averaged across all cultivars within each MG set.