Auburn University Crops:

Soybean Research Report

2016

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Auburn, AL

In cooperation with the Alabama Cooperative Extension System
(Alabama A&M University and Auburn University)

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Confidential Report

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I. Cultural Management

Developmental Work on the Creation of an Easy-to-Use, Low-Cost Regional Irrigation Scheduling Tool for Soybeans

D. Delaney, G. Vellidis, and W. M. Porter

Introduction:
Alabama row crop producers have greatly increased the amount of irrigation of soybeans in recent years. Irrigation scheduling tools have the potential to aid in increasing water use efficiency and yield while decreasing costs. However, irrigation scheduling in soybeans has not been widely adopted due to the lack of easy-to-use tools. Easy to use apps are available for other crops, however, more information is needed to adapt them to soybeans. In particular, crop co-efficient values need to be determined to relate water use at different crop stages to potential (theoretical) evapotranspiration. A regional effort is needed to determine these values and to test their use on various soil types and conditions, in order to create an accurate irrigation scheduling app.

The objectives of the project are:

1. Supply data from Alabama from unique location and soil types, to assist in creation of an easy-to-use, low-cost regional irrigation scheduling tool for soybeans.
2. Monitor water applied, soil moisture and crop growth of soybeans produced in selected regions of Alabama.

PROCEDURES:
A soybean field was selected at the Dee River Ranch in Pickens County with an existing center pivot system. Soil type was primarily a Vaiden silty clay, a typically farmed Black Belt soil, with high shrink-swell characteristics. A relatively uniform arc of a pivot (25 acres) was selected and irrigation zones and soil moisture monitor locations selected (Figure 1), based on previous years' yield maps. Eighteen soil moisture monitors were installed three weeks after the May 12 soybean planting. Each monitor was equipped with sensors at depths of 6, 12, and 24 inches. Moisture data was continuously downloaded until just before harvest, via a radio and cell phone network, to a web site for monitoring. A nearby NRCS-SCAN weather monitoring site supplied information on rainfall and temperature.

Variable rate nozzles were installed on the pivot system, and three irrigation threshold treatments (25 kPa, 50kPa, and 75 kPa of tension) applied to the assigned zones. Irrigation amounts varied from 4.25 inches to 8.75 inches, depending on the Zone and treatment threshold. In spite of the varying amount of irrigation water applied, yields were primarily in the mid-6o bu/A range for all irrigation threshold treatments.

Analysis of the data is continuing to better correlate yield to irrigation threshold, and to further refine the crop water use co-efficient values compared to crop growth, to use in the Regional Irrigation Scheduling Tool for Soybeans.

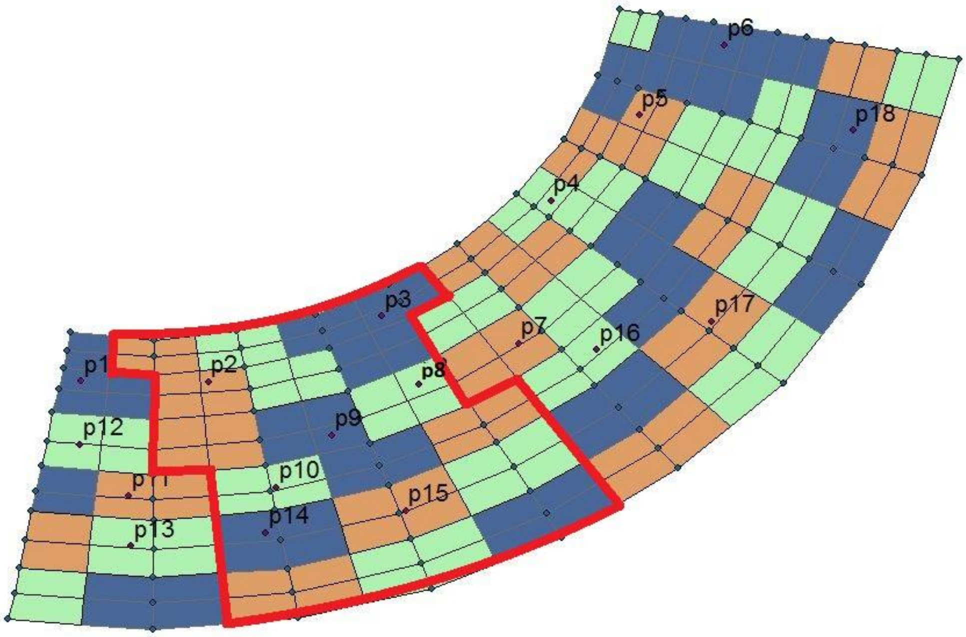


Figure 1. Layout of the irrigation treatments evaluated on a field at the Dee River Ranch

A M.S. graduate student enrolled in Biosystems Engineering at AU is assigned to the project. His duties include collecting and correlating data from soil and plant measurements, and collecting more intensive information during the growing season(s).

Cover Crop Mixtures for Soybean Production

D. Delaney, K. Balkcom, and A. Price

Introduction:

Alabama row crop producers have widely adopted conservation tillage, with many using winter cover crops before summer crops, including soybeans. Recently, cover crop seed mixtures have been promoted and adopted by producers in soybean growing areas. There is little data available in the southeast U.S. to show whether there is an advantage for soybean producers to use cover crop mixtures compared to a single species, and how to manage planting them, including the proper ratio of each seed component.

Summary

Field studies were conducted at two Experiment Station locations (EV Smith = EVS and Prattville = PEF) using different combinations and ratios of cover crops, beginning in the fall of 2015 for the 2016 soybean crop. The same treatments of cover crops were planted again in the fall of 2016. Twelve cover crop treatments were tested, with one to three species (cereal rye, crimson clover, and radish) with varying seed ratios of each, such as full, one-half or one-third of the recommended rates. Each treatment was replicated 4 times.

Cover crops biomass samples of 2 * ¼ meter^2 per plot were taken (May 5 –EVS, May 6-PEF) immediately before termination, dried, weighed, and analyzed for carbon and nitrogen content. Soybeans (EVS - Asgrow G75X6; PEF – Pioneer 67T25) were planted no-till approximately 2 weeks later after covers had dried down. Measurements were also made of stand counts, height and yield.

Heavy winter rains affected stands and biomass of cover crops, particularly at EVS. Extremely hot and dry late summer weather limited soybean yields at both locations. (Table 1) At PEF, soybean stand count was significantly greater for No cover crop compared to all Cover Crop treatments, while there was no difference in stand counts at EVS (data not shown). Soybean height slightly increased for some treatments at PEF, while all Cover Crop treatments increased soybean yields there by 3 to 10 bu/A. However, there were no significant differences for soybean heights or yields at EVS.

Table 1. Biomass, Soybean Height and Yield Following Cover Crop Mixtures at EVS and PEF

	Seeding rates			**Biomass**		**Soy height**		**Yield**	
	Lb/A			**Lb/A**		**inches**		**Bu/A**	
Treatment	Rye	Cr Clover	Radish	EVS	PEF	EVS	PEF	EVS	PEF
1	0	0	0	445	0	36.1	22.8	22.7	27.2
2	90	-	-	5363	2580	36.6	24.1	19.6	34.6
3	-	20	-	3034	8476	35.0	28.3	19.8	38.6
4	-	-	8	2178	3497	37.8	24.6	18.1	30.5
5	45	20	-	4738	7607	36.4	25.8	19.2	36.7
6	30	20	-	4511	8119	35.2	26.2	18.9	39.1
7	45	-	8	3687	2571	36.4	25.9	21.1	32.3
8	30	-	8	3645	3232	35.9	25.8	20.5	30.7
9	-	20	8	5138	7735	36.0	29.4	20.1	37.5
10	-	10	8	4348	7316	34.3	26.5	20.6	37.0
11	45	10	4	4520	7008	36.0	25.9	21.1	35.4
12	30	10	4	4773	6760	35.7	25.4	18.7	37.4
		LSD *(p=0.10)*		*1473*	*1630*	*NS*	*2.0*	*NS*	*2.7*

The Old Rotation

D. Delaney, K. Balkcom, and T. Cutts

The "Old Rotation" experiment (circa 1896) is the oldest, continuous cotton study in the world and the third oldest field crops experiment in the U.S. on the same site. With the renewed interest in cover crops, we believe that this is the oldest "cover crop" study in the U.S. and it is beginning to get more international attention. Many students at Auburn are using this study for special-problems research, as well as graduate students from other Universities in Alabama, while soils from the Old Rotation have been shared with researchers in Ohio, Louisiana and Texas.

Corn and cotton yields reflect soil moisture and N availability more than any other factors. There was a response to irrigation in 2016 by cotton, corn and soybean. Wheat always follows corn and soybean is double-cropped behind wheat. Wet spring weather contributed to delayed planting of summer crops, while extremely hot and dry late summer weather contributed to lower yields for later planted crops, esp. double-cropped soybeans.

Six soil moisture monitors were installed and monitored again in 2016 to optimize irrigation amounts and timing. A camera overlooking the Old Rotation allows visitors to the Old Rotation web site to view a live image of crops growing on the Old Rotation.
http://cses.auburn.edu/old-rotation/live-cam/

Table 1. Crop Yields on the Old Rotation in 2016

		Clover dry matter* (lb/a)		Wheat (bu/a)	Corn (bu/acre)		Cotton lint (lb/acre)		Soybean (bu/acre)	
		Irrigated	Non-irrigated		Irrigated	Non-irrigated	Irrigated	Non-irrigated	Irrigated	Non-irrigated
1	no N/no legume	0	0				723	334		
2	winter legume	1764	3900				1389	798		
3	winter legume	1232	2549				1389	854		
4	cotton-corn	2066	2967				1690	1014		
5	cotton-corn + N	1388	3203				1342	1023		
6	no N/no legume	0	0				685	404		
7	cotton-corn	1271	2901		44.3	65.5				
8	winter legume	1140	2665				1333	967		
9	cotton-corn + N	1597	2370		178.8	74.6				
10	3-year rotation	-	-	45.6*					50.3	25.9
11	3-year rotation	0	0				1183	835		
12	3-year rotation	3039	3217		188.7	73.5				
13	cont. cotton/no legume, +N	0	0				798	826		
	Mean	1687	2971		137.3	71.2	1170	784		

*Winter legume and wheat ares not irrigated. Average total N fixed by legume is 60 lb. N/acre.

Cullars Rotation

D. Delaney, K. Balkcom, and T. Cutts

The Cullars Rotation (circa 1911) is the oldest, continuous soil fertility study in the Southern U.S. This study is non-irrigated and yields reflect growing conditions during the season.

While some differences due to fertilization were observed, unusually sustained hot, dry weather limited yields and fertility responses on this sandy soil in 2016. Corn and soybean yields were extremely affected by hot, dry late summer weather. Conversely, clover and wheat yields were affected by wet soils in the early spring, which also delayed planting of summer crops.

All P and K fertilizers are applied to the cotton and wheat crops. Corn receives 120 lb. N/acre in addition to the fixed N by the winter legume cover crop. Wheat is top dressed in late winter with 80 lb. N/acre. The Cullars Rotation Experiment is an excellent site to see dramatic nutrient deficiencies compared to healthy crops each year. This type of comparison does not exist anywhere else in the USA. Numerous national and international groups were hosted at this experiment and 3 A.U. classes visited the site in 2016.

Table 1. Crop Yields on the Cullars Rotation in 2016

Plot	Treatment description	Clover/Vetch dry wt.	Wheat	Corn	Cotton lint	Soybean
		-lb/acre-	-bu/acre-	-bu/acre-	-lb/acre-	-bu/acre-
A	no N/+legume	1736	13.1	39.9	864	8.2
B	no N/no legume	0	7.3	25.6	929	6.7
C	Nothing added	0	0.0	0.0	0	1.6
1	no legume	0	44.7	45.7	929	7.1
2	no P	489	15.8	6.9	629	7.5
3	complete	2687	33.9	35.8	864	9.1
4	4/3 K	2249	53.9	21.2	554	11.7
5	rock P	2249	41.9	27.1	995	9.6
6	no K	628	33.2	0.0	0	6.0
7	2/3 K	2998	44.0	26.0	638	10.0
8	no lime (pH~4.9)	0	0.0	0.0	0	0.6
9	no S	1309	52.2	27.1	648	10.5
10	complete+ micros	1153	43.8	37.7	695	10.4
11	1/3 K	1672	45.2	31.8	338	11.6
	Mean of all treatments	1226	30.6	23.2	577	7.9

Soybean Production Tools for Alabama

D. Delaney, E. Sikora, K. S. Lawrence, M. Runge, J. Howe, R. Yates, E. McGriff, C. Hicks, K. Wilkins, B. Dillard, and T. Sandlin

OBJECTIVES:

Objective 1: To evaluate soybean cultivars suitable for Alabama growing conditions under producer practices and growing conditions.

Results: On-farm variety trials were planned at six sites across the state with seed obtained from participating seed companies and cooperators lined up. The wet spring caused delays for many of our planned farmer-cooperators, so that planting of most trials was much delayed, and several cooperators declined to participate due to time constraints. Extremely dry weather after wheat harvest caused some trials planned for double-cropping to be delayed until past mid-July and those were dropped. Of the 6 trials planned, only 2 could be harvested: in Cherokee and Marengo Counties. Both locations were dryland and affected by late summer dry weather.

In Cherokee County, eleven varieties were planted on 13 June and harvested 11 October. Yields ranged from 15 to 28 bu/A. Seed size was extremely small due to drought during seed fill.

In Marengo County, a Black Belt soil site was chosen with areas of high pH. Due to dry weather, a poor stand was obtained in sections of the field, and comparable areas with good stands were harvested. Yields ranged from 32 to 45 bu/A, helped by late summer showers. Yield results are being analyzed in comparison to iron chlorosis, but analysis is not yet complete.

Objective 2: Evaluate the use of treatments to control iron chlorosis on high pH Black Belt soils.

Results: Some reports as well as field observations have shown that increased populations of soybeans can lessen symptoms of iron chlorosis on high pH soils. An experiment was conducted at the Black Belt REC on a high pH (8.1) soil using six seeding rates ranging from 90,000 to 240,000 seeds/acre. Plots were no-till planted with Pioneer 95Y70 (RR) soybeans, a variety rated relatively tolerant for iron chlorosis. Due to being no-till planting into a grass cover crop and good early season growing conditions, iron chlorosis was limited, with no significant differences *(p=0.10)* between treatments (Table 1).

Although seeding rates of 180,000 and greater had statistically significant increases in yield compared to lower seeding rates, differences were relatively small due to the low yields resulting from late summer drought.

Table 1. Seeding Rate Effects on Iron Chlorosis and Yield of Soybeans on High pH Soils, BBREC 2016				
Treatment	**Seeding rate/A**	**Fe-chlorosis***	**Yield Bu/A**	
1	90,000	3.3	5.9	c
2	120,000	3.0	6.1	c
3	150,000	3.3	7.1	bc
4	180,000	2.3	10.5	a
5	210,000	2.8	9.5	ab
6	240,000	3.0	9.6	ab
	LSD (p=0.10)	*NS*	2.54	
*Chlorosis Ratings 0-10: 1 = no chlorosis, 10=dead				

Objective 3: Evaluate nitrogen applications to soybeans in high yield environments. Several soybean yield contest winners across the country have applied additional N fertilizer for yield enhancement; however, we have very limited data in AL at high yield levels whether N application has benefits while optimum timing and rates are unknown.

Results: Tests were conducted at the Tennessee Valley REC, EV Smith Field Crops Unit and Sand Mountain REC with soybeans under irrigation.

At TVREC, Pioneer 54T94 was planted on May 16 in 30-inch rows. At EVS, Asgrow AG75X6 was planted on May 24 in 36-inch rows. Urea nitrogen was applied either At-plant, at the R3 growth stage, or split between the R3 stage and 21 days later. Rates of 0, 40, 80, 120 or 160 lb/A of N were used. Plots were monitored for lodging and other problems, while seed samples were analyzed for 100-seed weight and protein and oil content (data not shown).

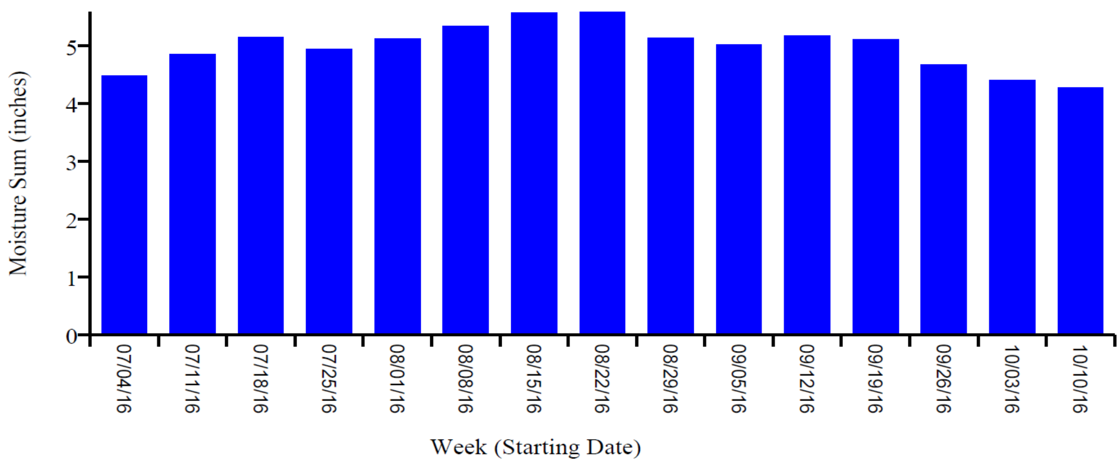
At TVREC, yields ranged from 43 to 52 bu/A with no significant effects on yield for the Rate of N applied (Table 2). At EVS, yields ranged from 37 to 41 bu/A, and at SMREC ranged from 52 to 61 bu/A with no significant differences for rate of N applied. No effects on plant height, lodging or delayed maturity were noted in any trial. Data analysis is ongoing to determine effects of timing or splits of N application on yield and seed components.

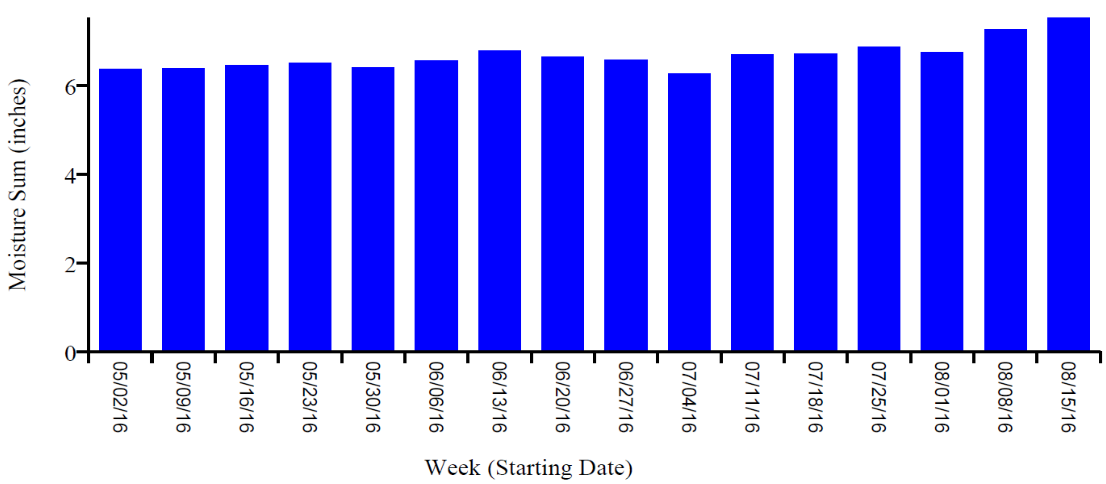
Table 2. Effect of Nitrogen Application Rates and Timing for Soybeans, TVREC, EVS-FCU, and SMREC 2016				
Nitrogen	**Nitrogen**	**TVREC**	**EVS-FCU**	**SMREC**
Timing	**Rate (lb/A)**	**Bu/A**	**Bu/A**	**Bu/A**
At-plant	40	44.8	38.6	59.8
At-plant	80	45.6	38.4	56.8
At-plant	120	44.7	40.7	59.3
At-plant	160	46.1	39.7	57.8
R3	40	41.7	33.3	57.7
R3	80	50.2	41.5	52.5
R3	120	52.5	38.4	53.8
R3	160	49.7	37.5	58.9
Split: R3, + 21 days	80	48.7	37.8	59.5
Split: R3, + 21 days	120	46.1	40.3	58.7
Split: R3, + 21 days	160	49.6	37.0	61.0
Untreated	0	43.5	38.0	59.1
	LSD (p=0.10)	*NS*	*NS*	*NS*

Comparison of On-Farm Irrigation Scheduling Practices in Southeast Alabama Crop Production

B. A. Dillard, J. Kelton, and A. Bouselmi

The objective for the first year was to "blind fold" the farmers and evaluate their irrigation practices by the data from the soil moisture probes. In 2017, we will be conducting research at the Wiregrass Research & Extension Center to compare different irrigation scheduling methods while monitoring them with soil moisture probes. We will also be back onto the farms with these probes to compare farmers from last year to this year with using the moisture probes.





Improvement of Irrigation Management on Alabama Black Belt Soils

T. Knappenberger, B. Ortiz, D. Delaney, and J. Shaw

Introduction

Several soybean growers in Alabama's Black Belt Region have installed central pivot irrigation systems in recent years. However, soybean yield response on these heavy textured soils is often times smaller than anticipated. To improve irrigation and soil water management, it is necessary to investigate the yield limiting factors.

Material & Methods

On-farm research was carried out on the Dee River Ranch in Aliceville, Alabama. This location was chosen for its unique combination of irrigation and tile drainage. The research field has two irrigation pivots and part of the field is tile-drained (Figure 1) resulting in four treatments: dryland, dryland & tile-drained, irrigated, and irrigated & tile-drained.

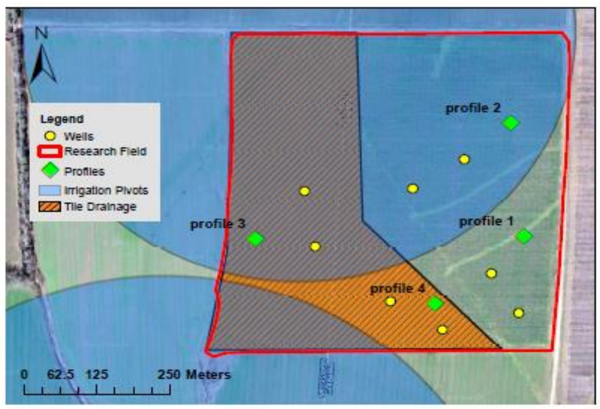


Figure 1: The research field on the Dee River Ranch.

Data loggers were installed to measure soil water content (depths of 15, 30, and 60 cm), matric potential (15 cm), and groundwater level on four locations, one for each treatment. The data loggers and the sensors were installed after planting in May 2016 and were removed before harvest at the beginning of September 2016. Additionally, we installed 8 groundwater wells as shown in Figure 1.

Root growth was monitored at 20 profiles, 5 in each treatment. At each profile, several images from the root zone were taken and later analyzed in the lab for roots.

Yield was measured with a commercial combine yield monitor. Because the four treatment areas "dryland", "dryland & tile-drained", "irrigated", and "irrigated & tile-drained", were different in size, we needed to create a yield data set with equal observations per treatment. Between treatments was a 120 feet buffer where yield was not assessed to avoid blending effects.

Results

Figure 2 shows rainfall and irrigation data for the study time period. Rainfall occurred frequently every week to every second week. Rainfall was 240 L/m2 (9.4 inches) between May 19th and September 1st. In that time period, the research field was irrigated four times with amounts between 19 and 25 L/m2 (0.75-1 inches) resulting in an overall irrigation volume of 89 L/m2 (3.5 inches).

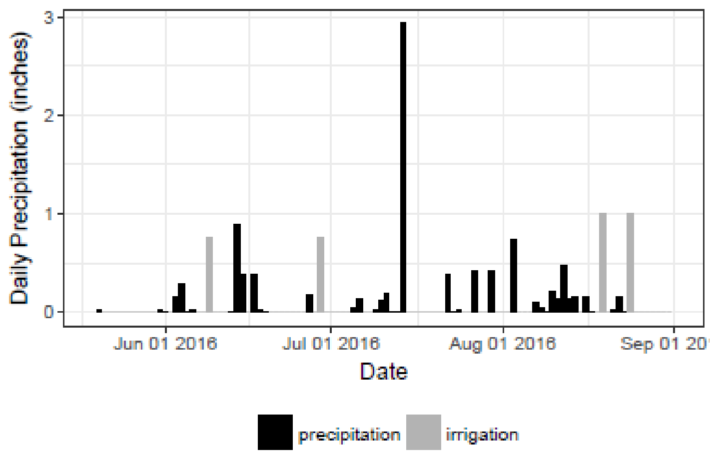


Figure 2: Rainfall and irrigation pattern over the research time period.

Figure 3 shows the matric potential of the four locations in a depth of 15 cm (6 inches). The black horizontal line is at a matric potential of -50 kPa. Plants are considered to suffer water stress at matric potentials below -50 kPa which is why this value is considered as an irrigation trigger. Irrigated treatments have higher matric potentials with values above -50 kPa for most of the research period (Figure 3). Dryland treatments have lower matric potentials and plants in the dryland may have suffered more water stress than plants under irrigation.

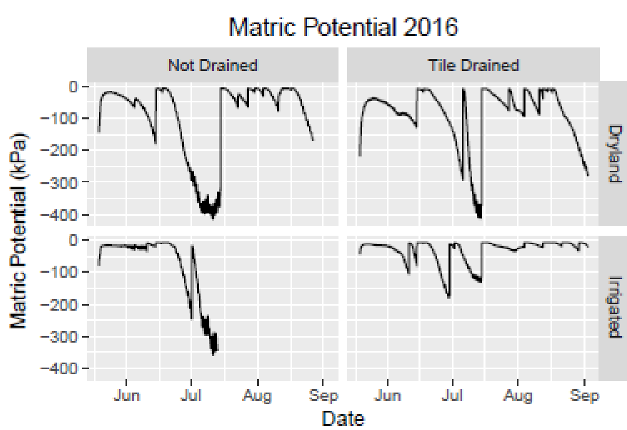


Figure 3: Matric potential at the four treatment locations in a depth of 15 cm (6 inches).

With lower matric potentials in the dryland the volumetric water content was consequently also lower in the dryland in a depth of 15 cm (6 inches). Figure 4 shows the volumetric water content for depths of 15, 30, and 60 cm (6, 12, and 24 inches). The water content of dryland and irrigated land differ in depths of 15 and 30 cm (6 and 12 inches) with the most distinct differences in 30 cm depth (12 inches). The water content in 60 cm (24 inches) does not seem to be affected by irrigation as all values are at about the same magnitude.

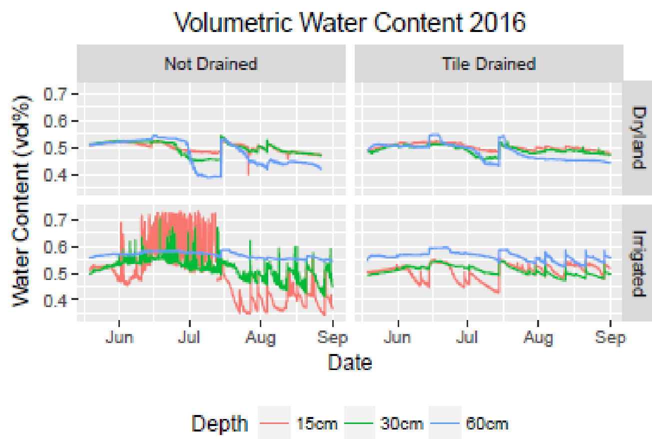


Figure 4: Volumetric water content in depths of 15, 30, and 60 cm (6, 12, and 24 inches).

The groundwater table well depths were 6 feet in all treatments. Based on the results from 2015 we have dug the wells deeper. Figure 5 shows the groundwater levels over the research time period.

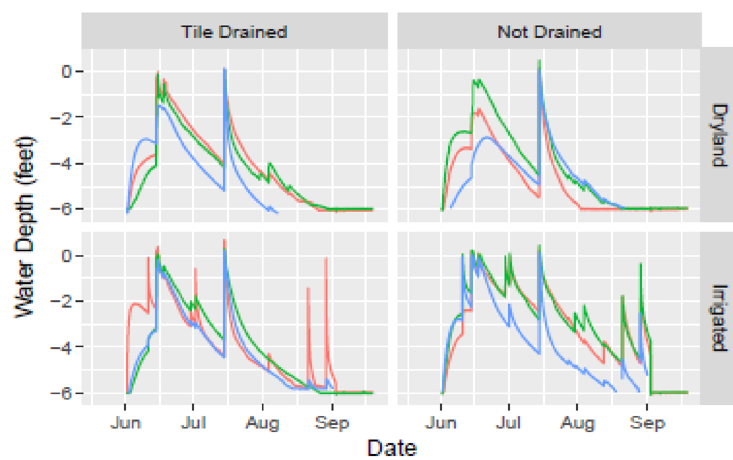


Figure 5: Groundwater levels at each monitor location.

Yield was measured with a commercial combine yield monitor. Figure 6 shows the average yield per treatment and year. In 2016, the "dryland" treatment had the lowest yield (63 bu/acre) followed by "irrigated" (69), "dryland & tile-drained" (72), and "irrigated & tile-drained" (76). Interestingly, the "dryland & tile-drained" treatment resulted in a higher yield than the "irrigated" treatment.

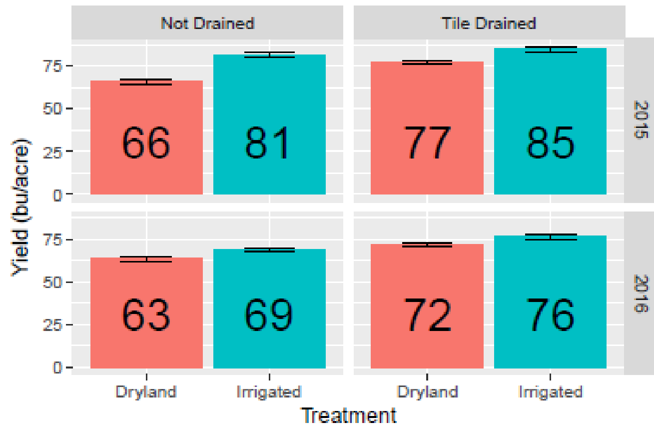


Figure 6: The average yield for 2015 and 2016. Numbers are in bushels/acre.

Root analysis per depth increment is shown in Figure 7. We hypothesized that tile drainage increases rooting depth. The root volumes in the lowest image window in 24-32" depth were: "dryland" (7.4), "dryland & tile-drained" (13.7), "irrigated" (12.1), and "irrigated & tile-drained" (12.1). Both, drainage and irrigation increased rooting depth.

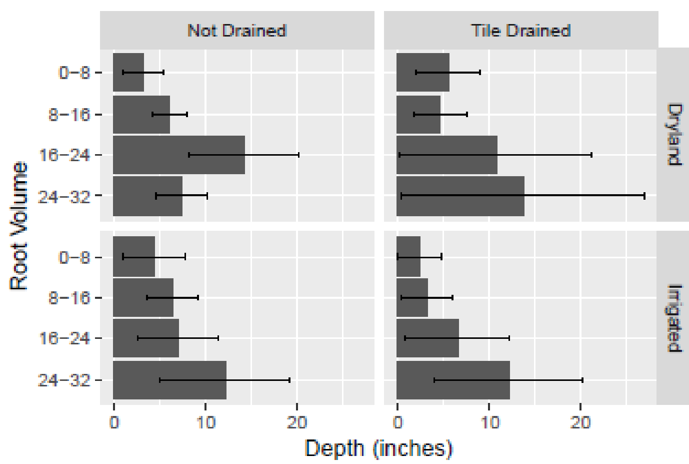


Figure 7: Average root volumes per image depth increment.

Discussion

The results show that tile-drainage and irrigation both increased the yield. The research field was irrigated and irrigation showed clear effects on matric potential (Figure 3) and yield (Figure 6). The 2016 drought was probably too late in the growing season to affect the yield in the dryland treatments. This study needs to continue to be able to make stronger conclusions about the effects of irrigation and tile-drainage on Blackbelt soils.

The rooting depth was considered as a yield limiting factor and the water table was expected to be very shallow limiting the rooting depth. However, the data from our monitoring wells (Figure 5) indicate deeper groundwater levels than expected, at least for the later growing season. Other than groundwater rooting depth is also affected by the gas exchange capacity of a soil as roots need oxygen. Heavy and fine textured soils like the Blackbelt soils have low gas exchange capacities.

Future Research

- Similar experiments should continue on this location because of its unique combination of irrigation and tile-drainage allowing to study effects of both within immediate vicinity.
- Corn will be grown on this field in 2017 and we will continue with this research in corn at the same location.

Variable Rate Irrigation Based on Soil Sampling and Sensor Techniques

T. Knappenberger, J. Howe, J. Shaw, D. Monks, and G. Pate

Introduction

Over the past several years, agriculture techniques have been developed that allow more precise lime, fertilizer, and pesticide application. Techniques for adapting crop-seeding rates to yield goals are now possible and will become more valuable as the technology advances. Drones allow public and private crop advisors to observe the crop from a completely different viewpoint. As this technology develops and research data sets are more complete, real-time in-season management will become more advanced as well.

The Alabama Agricultural Experiment Station has made a large investment in the past 3 years in variable rate irrigation (VRI). Within the next year, VRI will be possible at the TVREC in Belle Mina, SMREC in Crossville, GCREC in Fairhope, and WGREC in Headland. Currently, field scale, variable rate center pivot irrigation is being utilized at the EVSRC in Shorter, AL. Greg Pate, EVSRC director, has been working with Dr. Ortiz, Dr. Hagan, and others to conduct research that will make full use of this new technology.

Our objective in 2016 was to assess the yield response of eight cultivars on irrigation depth.

Material & Methods

The cultivars Asgrow 5831 R, Pioneer 52T50 R, Pioneer 54T94 R, Asgrow 5533 R, Pioneer 55T81 R, Pioneer 56T12 S, Pioneer 56T29 R2, Pioneer 95Y70 R were evaluated for yield response on different irrigation depths. Treatments included dryland (no irrigation), 0.375", 0.75", 1.125", and 1.5". Soy beans were irrigated on:

- 6/3/16 - 0.5" across everything to encourage stand establishment
- 6/24/16 - 0.75" Treatments applied for first time.
- 7/11/16 - 1.5" Treatments applied
- 7/18/16 - 1.5" Treatments applied and then immediately received greater than 1" rainfall
- 7/26/16 - 1.5" Treatments applied
- 7/30/16 - 1.5" Treatments applied
- 8/27/16 - 1.5" Treatments applied

All cultivars were planted at 150,000 seed per acre. Crop management: Burndown with Gramoxone Inteon (1qt/a); Layby Roundup PowerMax (1qt/a).

Results

The cultivar with the highest yield was Pioneer 52T50 R followed by Asgrow 5530 R. Both cultivars yielded significantly higher than the other tested cultivars (Figure 1). The performance of each cultivar per irrigation treatment is shown in Figure 2. Figure 3 shows a ranking of the eight cultivars per irrigation treatment. For all treatments, Pioneer 52T50 R outperformed the other cultivars. We also want to point out how Pioneer 52T94 R ranked: in the dryland treatment it was ranked second last and with increase of irrigation depth the performance of Pioneer 52T94 R increased. At last, it ranked second in the treatment with the highest irrigation depth.

Future Research

We will continue to evaluate the performance of cultivars under irrigation treatments. For 2017, we plan to implement irrigation strategies that include irrigation timing and irrigation depth. We will evaluate the check book method, sensor based irrigation (watermarks), and irrigation based on growth stage.

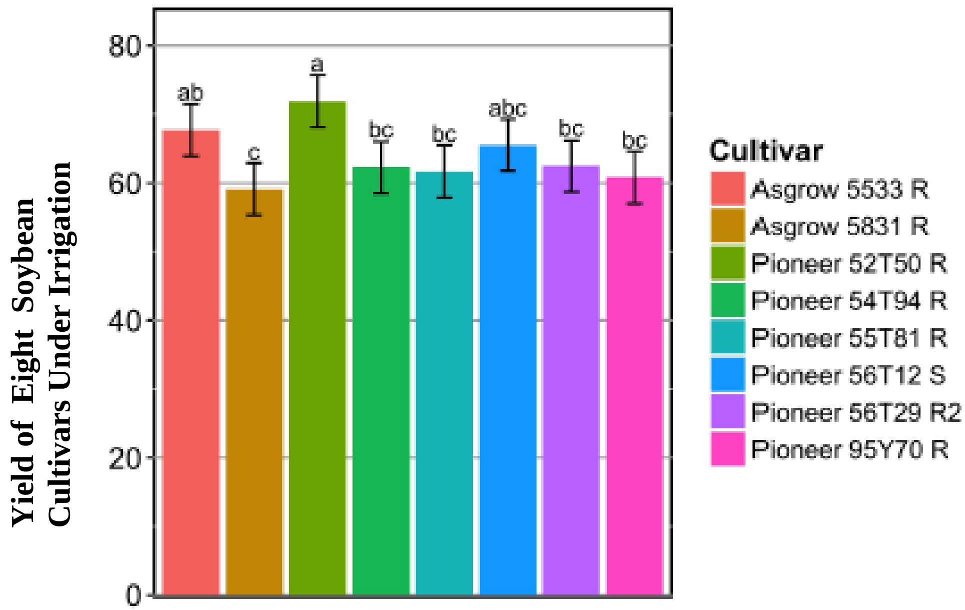


Figure 1: The research field on the Dee River Ranch.

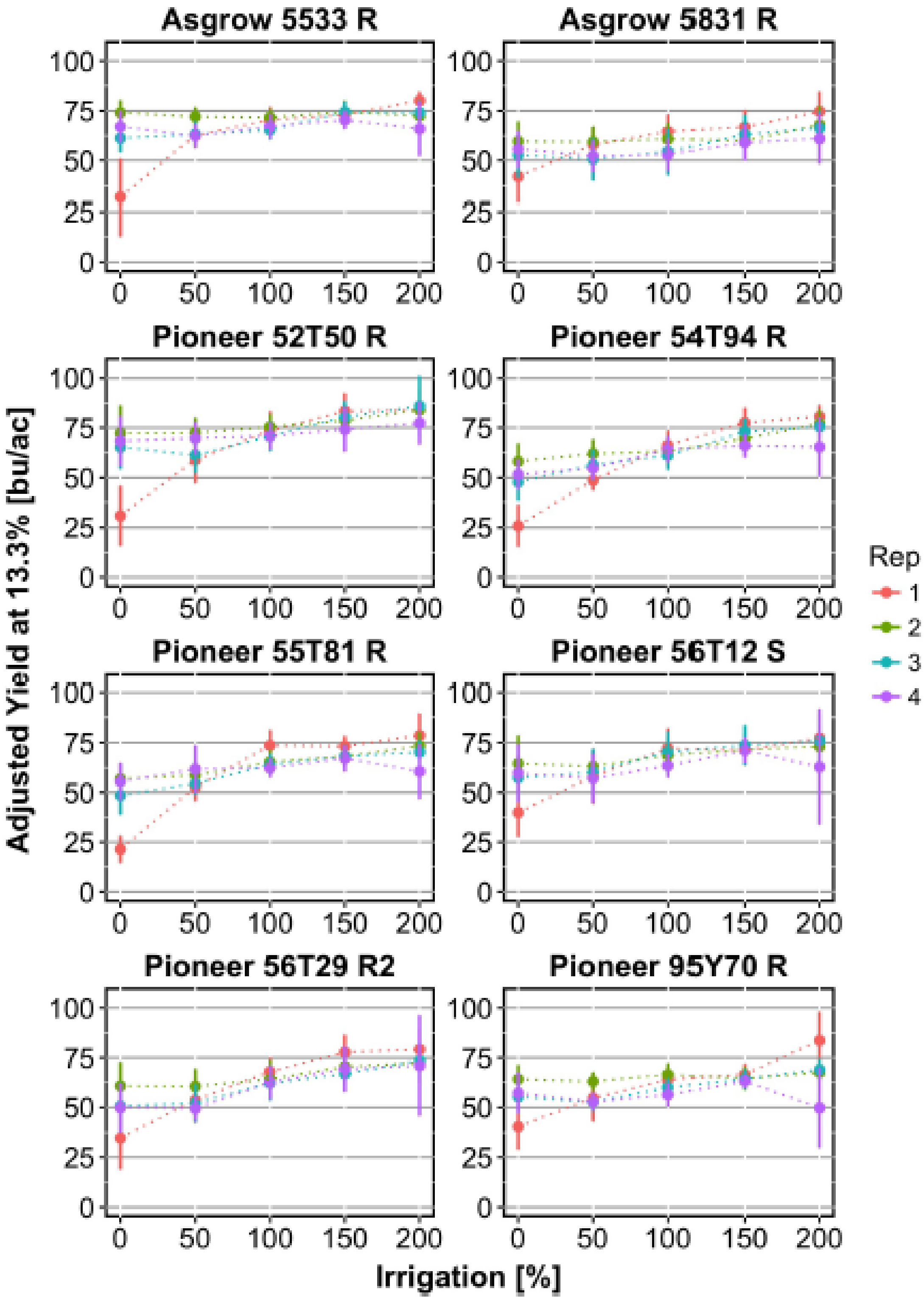


Figure 2: The research field on the Dee River Ranch.

	Irrigation [%]				
Rank	0%	50%	100%	150%	200%
1	Pioneer 52T50 R	Pioneer 52T50 R	Pioneer 52T50 R	Pioneer 52T50 R	Pioneer 52T50 R
2	Asgrow 5533 R	Asgrow 5533 R	Asgrow 5533 R	Asgrow 5533 R	Pioneer 54T94 R
3	Pioneer 56T12 S	Pioneer 56T12 S	Pioneer 56T12 S	Pioneer 56T12 S	Pioneer 56T29 R2
4	Pioneer 95Y70 R	Pioneer 55T81 R	Pioneer 55T81 R	Pioneer 54T94 R	Asgrow 5533 R
5	Asgrow 5831 R	Pioneer 95Y70 R	Pioneer 56T29 R2	Pioneer 56T29 R2	Pioneer 56T12 S
6	Pioneer 56T29 R2	Pioneer 54T94 R	Pioneer 54T94 R	Pioneer 55T81 R	Pioneer 55T81 R
7	Pioneer 54T94 R	Asgrow 5831 R	Pioneer 95Y70 R	Pioneer 95Y70 R	Pioneer 95Y70 R
8	Pioneer 55T81 R	Pioneer 56T29 R2	Asgrow 5831 R	Asgrow 5831 R	Asgrow 5831 R

Figure 3: The research field on the Dee River Ranch.

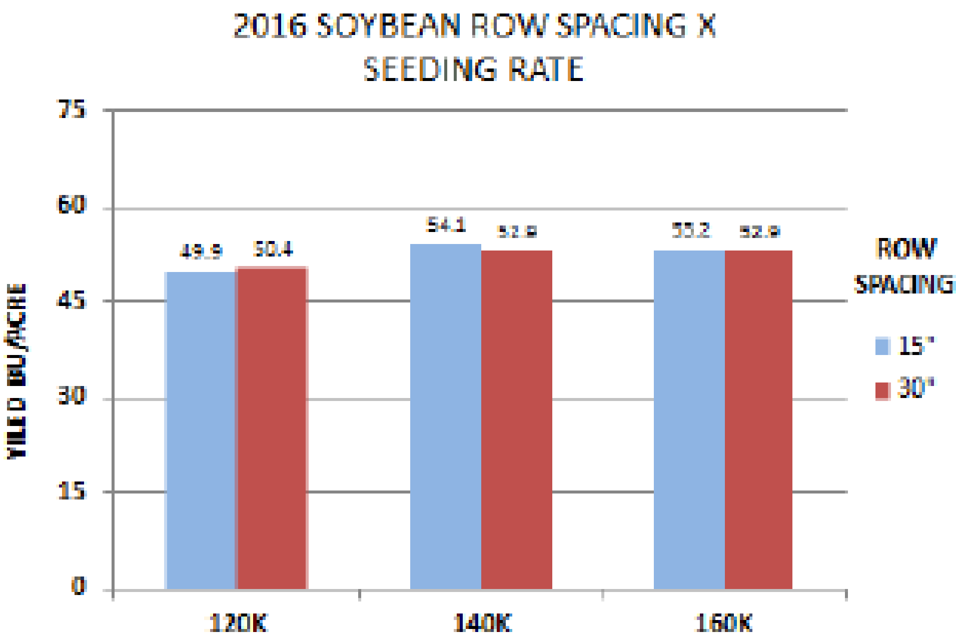
Row Spacing and Population Density Effect on Soybean Seed Yield

T. Sandlin, D. Delaney, and M. Hall

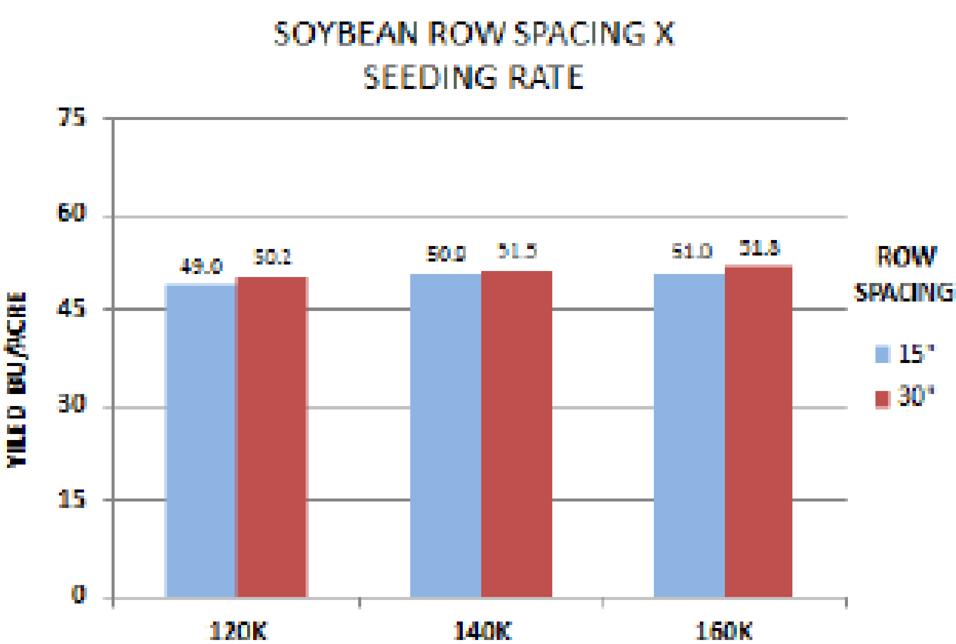
One on-farm soybean row spacing and seeding rate trial was conducted in 2016. Early season drought and reduced full-season soybean acres did not lend itself to early-planted trials. Therefore, this test was double cropped behind wheat. This test was located on farm in Limestone County (Elkmont, AL). The test was planted June 25, 2016 with Asgrow 5831 RR2 soybeans and harvested on October 19, 2016. The test contained one large strip for each treatment 37.5 feet in width and row length 440 feet. Yields were as follows for each treatment (1) 15” row x 120,000 seeding rate [50.5 bu/A] (2) 15” row x 140,000 [55.0 bu/A] (3) 15” row x 160,000 seeding rate [54.2 bu/A] (4) 30” row x 120,000 seeding rate [51.2 bu/A] (5) 30” row x 140,000 seeding rate [53.8 bu/A] (6) 30” row x 160,000 seeding rate [53.6 bu/A].

Two year average yields for 3 locations averaged together are as follow for each treatment (1) 15” row x 120,000 seeding rate [49 bu/A] (2) 15” row x 140,000 [50.9 bu/A] (3) 15” row x 160,000 seeding rate [51.0 bu/A] (4) 30” row x 120,000 seeding rate [50.2 bu/A] (5) 30” row x 140,000 seeding rate [51.3 bu/A] (6) 30” row x 160,000 seeding rate [51.8 bu/A].

No significant differences were seen with respect to soybean yield for this test. Soybean seeding rates of 140,000 and 160,000 proved to yield slightly greater numerically for both row spacings. Weed control was monitored with little to no differences observed for any treatment. Consideration should be given to variety and potential for resistant weed populations when choosing soybean row spacing.



ASGROW 5831 RR2
Elkmont, AL



Two Year Avg.
3 Locations

Soybean Improvement and Germplasm Enhancement

J. C. Koebernick

In August of 2016, Dr. David Weaver retired and Jenny Koebernick stepped into his role, taking over current research/field projects. The primary project is to utilize the oil-producing capacity of Henderson, a Maturity Group VIII cultivar, known for high yield and oil, to produce a non-GMO high oleic acid soybean oil. In 2014, Henderson and S13-16219 (a source of the high oleic acid trait licensed to us by USDA and the University of Missouri) were successfully crossed and 22 F_1 hybrid seed were obtained. An additional cross that was made was G10PR-2242R (elite experimental line from the University of Georgia) × S13-16188 (a line similar to S13-16219 and having the high oleic acid trait). In 2016, the F_2 seed were advanced under irrigation to produce the F_3 generation. These seed will be analyzed for the high oleic trait. This combination of a high oil production genotype coupled with the positive influence of high temperatures during the growing season will make this a very attractive package for producers interested in the high-oleic specialty market.

Our main research effort continues to focus on participation in the USDA Uniform Cooperative Tests, growing 12 tests in 3 locations (Tallassee, Belle Mina, and Fairhope) and evaluating over 230 elite public breeding lines of Maturity Groups V, VI, VII and VIII in both Preliminary and Uniform Tests. This continues to be a major resource of genetic material, as well as a great testing network for evaluation of new genotypes from all public breeding programs in the Southeast. Without these tests, there would be no evaluation of elite public germplasm in Alabama. These lines not only are subject to release by the public developers, they also serve as a major source of germplasm for use by industry in development of high-yielding, good agronomic cultivars with transgenic traits for the production market. However, extensive resources, in terms of labor and materials, are required to conduct these tests. We receive no money from USDA. One additional aspect this year was that breeders across the southeast report very poor seed quality in their breeding programs due to extensive rainfall during harvest. The Belle Mina location produced seed of reasonable quality, and we are being looked upon as a seed supplier for many of these programs.

II. Fertilizer Management

Symbiotic Nitrogen Fixation in Roundup Ready Soybean

Y. Feng and D. Delaney

The objective of this project was to determine if glyphosate applications increase uptake of soil-derived nitrogen by Roundup Ready® (RR) soybean.

Results:
In 2016, we continued the field study to evaluate the growth and symbiotic nitrogen (N) fixation capacity of glyphosate-resistant soybean in response to post-emergence glyphosate applications. A randomized complete block design was used with four replications. Glyphosate treatments consisted of a single application (1.5 lbs ai/A), a sequential application (1.5 + 1.5 lbs ai/A), and a RR soybean (Prichard RR) control without glyphosate application. Isogenic conventional soybean (Prichard) was also included as a cultivar control. Seeds were inoculated with Rhizo-Stick peat inoculant containing Bradyrhizobium japonicum (2x108 cells/g) prior to planting on 08 June. The first glyphosate treatment was applied 21 days after planting (DAP) and the second treatment 35 DAP. Weeds in the two control treatments were managed by using other herbicides. Entire plants were harvested 42 and 99 DAP, corresponding to V8 and R5 growth stages, for evaluation of plant dry matter, nitrogen content and 15N natural abundance.

At the V8 growth stage (the first harvest), no significant treatment differences were observed for any of the 10 parameters measured. At the R5 growth stage (the second harvest), significant treatment differences were observed for root mass and root C/N ratio (Table 1). Nodulated root mass in conventional Prichard and Prichard RR receiving one glyphosate application were higher than the other two treatments, whereas root C/N ratios were lower. The percentage of plant N derived from symbiotic nitrogen fixation (%Ndfa) was calculated using 15N natural abundance data for shoots and no significant differences were found among treatments. On average, this year's grain yields were about 50% lower than last year due to drought. No significant differences were found among treatments for yield and seed weight. It is well known that drought negatively affects symbiotic nitrogen fixation in soybean. The drought stress may have masked the stress caused by glyphosate. This is the fourth and last year of this field trial.

Table 1. Effects of glyphosate application on selected parameters measured in the study

Treatment	Root mass	Root C/N	Grain yield	Seed weight
	(g/plant)		(bu/ac)	(g/100 seeds)
Prichard conventional	4.16a	44.9b	30a	10.4a
Prichard RR check	3.24c	78.7a	26a	9.9a
PrichardRR Roundup once	3.95ab	49.8b	28a	9.7a
PrichardRR Roundup twice	3.47bc	59.9ab	27a	9.9a

Field Assessment of Foliar Potassium Fertilizers for Soybeans

B. Guertal and D. Weaver

The experiment was conducted at the EVS Field Crops Unit in Shorter, AL. The experiment was installed on May 26th with Progeny 5555 soybean planted at 8 seeds per foot with a 36 inch row spacing. Each plot was 25 feet long and 4 rows wide, and there were 4 replications of each treatment. Treatments were arranged in a randomized complete block design, with a statistical design of a full factorial of K rate and K source, plus a zero-K control. Initial soil-test results found a soil pH of 6.2, P of 49 lb/A (a medium test) and K of 114 (a 'High' test). No K or lime was applied, but 40 pounds of P_2O_5 (as triple superphosphate) was applied prior to planting.

Irrigation was applied on 6 June (0.65 inches), 28 June (0.64), 30 June (0.40), 18 July (0.55) and 6 Sept (0.65 inches). The study was harvested on October 11th, with the middle two rows harvested for grain yield and determination of grain moisture. Yields shown below are corrected for moisture.

Specific foliar K treatments (as shown in the treatment list below) were applied on August 5th (~R2 growth stage) and August 19th (approximately R5). All foliar treatments were applied in a 10 gpa spray volume.

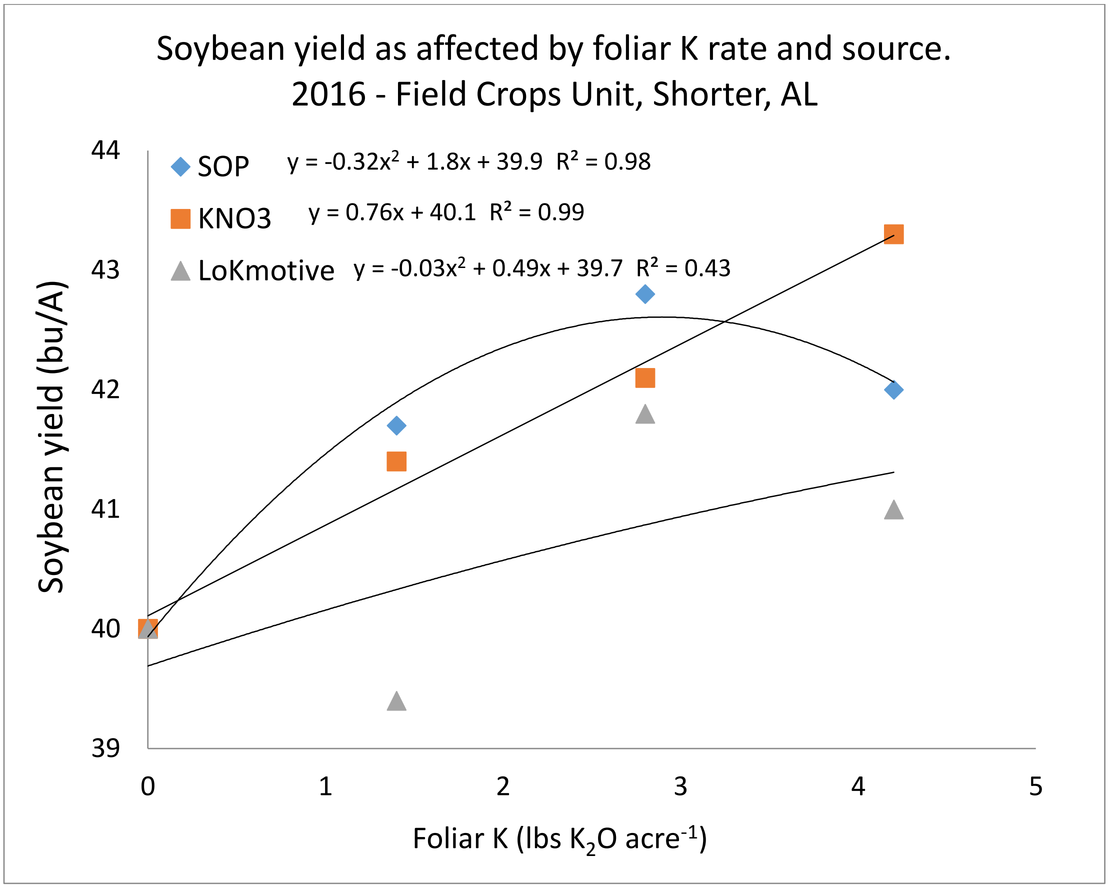
Potassium K Source and Rate Treatments, 2016 Foliar K Study:

Trt	K Source	K_2O Rate
		lb K_2O acre^{-1}
1	Potassium sulfate (SOP)	1.4
2	Potassium sulfate (SOP)	2.8
3	Potassium sulfate (SOP)	4.2
4	LoKomotive	1.4
5	LoKomotive	2.8
6	LoKomotive	4.2
7	Potassium nitrate (KNO_3)	1.4
8	Potassium nitrate (KNO_3)	2.8
9	Potassium nitrate (KNO_3)	4.2
10	No potassium	0.0

All treatments were balanced to uniformity of N application using urea to provide N equal to that applied in the highest K rate (with the potassium nitrate). Sulfur content was not adjusted.

Yield Results:

Note: Tissue K content is currently under analysis.



Comments:

In both 2015 and 2016 we have observed slight significant increases in soybean grain yield with application of foliar K. Yield tended to maximum at the medium rate of K fertilization – 2.8 lb K_2O per acre, and there was no additional yield benefit to adding more K. There were no differences due to K source, and responses were similar across the K sources. It should be noted that yield increases are slight – perhaps about 2 to 3 bushels. Thus, pricing out the cost of K fertilizer, application time and application costs should be weighed against the additional value of 2 to 3 bushels of soybeans per acre.

Yield Response of Soybeans Fertilized with Poultry Litter

M. Hall, T. Reed, and T. Sandlin

Yield Response and Economic Returns
For Different Fertility Treatments in Soybeans

Fertility Treatment Per Acre	**Treatment Cost**	**Yield/ Income**	**Yield – Treatment Cost**
Fertilize according to soil test soil test No Fertilizer	0.00	40.67/ $394.45	$ 394.45
Pre-plant with 2 tons poultry litter	80	43.23/ $419.33	$ 339.33
Pre-plant with 2.5 tons of poultry litter and top-dressed with 1.5 tons poultry litter at first bloom	160	45.57/ $442.03	$ 282.03
Pre-plant with 60-60-60 commercial fertilizer	70.78	42.62 / $413.41	$ 342.65

Values

Soybeans	$ 9.70 / bushel
Litter	$ 40.00/ ton spread
17-17-17	$ 401 / ton spread

This test was conducted at the Tennessee Valley Research and Extension Center using a randomized complete block design and 4 replications per treatment.
This test was planted on May 12 and harvested on October 3. There was no lodging in any of the treatments. 2016 was a very dry year.

Critical T Value 1.83

Improve Plant Health with Starter Fertilizers and Added Plant Hormones to Boost Soybean Yield Potential

K. S. Lawrence, E. Sikora, D. Delaney, and D. Dodge

Justification: Starter fertilizers and added plant hormones are being marketed as increasing soybean root growth. Do these additives increase plant health adequately to eliminate the stress and yield loss of reniform or root-knot nematodes?

Objectives: 1. Evaluate commercially available plant hormones for best rate and application timing for producing biomass in the presence of root-knot or reniform nematodes; 2. Evaluate starter fertilizers for optimum growth of soybean in the presence of each nematode; 3. Evaluate new nematicides for the best efficacy; and 4. Apply best plant hormone, starter fertilizer and nematicide combinations into microplot and field trials for soybean growing season 2017.

Materials and Methods:

Greenhouse trials: 1. Plant hormones including Indole Butryic Acid, Gibberellic Acid, and Cytokinin sold as the product Ascend™ were evaluated as a seed treatment, in-furrow spray, and a foliar spray to determine the effects on soybean plant growth in the presence of reniform or root-knot nematodes. 2. A second set of tests will evaluate starter fertilizers Neptune's Harvest, Sure-K, Pro-Germ, and Micro-500 were applied in varying combinations to determine the effects on soybean plant growth in the presence of our nematodes. 3. Third, a set of nematicide studies will evaluate the efficacy of the new and standard nematicides. All these tests will be conducted in the greenhouse. Soybean growth will be tested in 150 cc cone-tainers inoculated with 2000 reniform or root-knot eggs and allowed to grow in the greenhouse for 45 days before harvest. Data from greenhouse tests will determine the best plant hormone applications, starter fertilizer combinations, and effective nematicide.

Microplot and Field trials: The best plant hormone applications, starter fertilizer combinations, and nematicide will be tested in the microplots and in the field. Microplots are located at the PSRC and are artificially infested with reniform or root knot -nematodes. The field trials will be located at the TVREC in northern Alabama and at the PBU or Prattville in central Alabama. Plant growth parameters, nematode populations, and yield will be collected from the microplot and field trials.

Outcome: Identify the best combination of starter fertilizers, plant hormones and nematicides to enhance soybean yield in the presence of the root-knot nematode.

Results:

Greenhouse Plant Growth Regulator Trials

Ascend plant growth regulator treatments did not significantly increase plant biomass, plant height, root and shoot fresh weights over the control at 45 days after planting (DAP) (Table 1). The in-furrow spray treatment was 13% greater in biomass than the control; the in-furrow spray with an added foliar spray was 16% greater in biomass than the control. The in-furrow spray treatment significantly increased total *Meloidogyne incognita* eggs over the control; all Ascend treatments did not significantly increase *Meloidogyneincognita* eggs per gram of root compared to the control. The in-furrow spray was selected as a simple, yet effective treatment to be utilized in field trials.

Table 1. Plant growth regulator effects on average soybean root and shoot fresh weight, plant biomass, *Meloidogyne incognita* total egg numbers, and eggs per gram of root at 45 DAP in greenhouse trials.

Treatment	Rate	Root fresh weight (g)	Shoot fresh	Plant biomass	Total eggs	Eggs/g root
Control [z]	---	6.17 [y]	7.80	13.98	30282	2642
Ascend™ST	88.7 mL/cwt	5.98	7.90	13.88	48993	3594
Ascend™IFS	233.7 mL/ha	7.34	8.48	15.82	753079*	2122
Ascend™FS	292.2 mL/ha	5.28	7.27	12.55	42078	2839
Ascend™ST+ IFS	233.7mL/ha + 292.2 mL/ha	6.60	7.52	14.12	641607	3341
Ascend™ST+ FS	88.7 mL/cwt + 292.2 mL/ha	6.23	7.96	14.20	39134	2174
Ascend™IFS + FS	233.7 mL/ha+ 88.7mL/cwt	7.66	8.50	16.17	58203	2877
Ascend™ST+ IFS+ FS	88.7 mL/cwt + 233.7 mL/ha + 292.2mL/ha	5.78	7.42	13.21	50096	4805

[z]Ascend™ is comprised of cytokinin 0.090%, gibberellic acid 0.03%, indole butyric acid 0.045%. Ascend™ ST is a seed treatment, Ascend™ IFS is an in-furrow spray, Ascend™ FS is a foliar spray applied at 2 true leaf stage.[y] Means in the same column followed by * $P \leq 0.10$; ** $P \leq 0.05$ according to Dunnett's P values

Starter Fertilizer Greenhouse Trials

Pro-Germinator, Sure-K, Micro-500, Neptune's Harvest, Pro-Germinator plus Micro-500, and Neptune's Harvest plus Micro-500 significantly increased shoot fresh weight over the control at 45 DAP. Neptune's Harvest, Micro-500, Pro-Germinator, and Pro-Germinator plus Micro-500 significantly increased plant biomass compared to the control. Starter fertilizers had no significant effect on *M. incognita* eggs at 45DAP; *M. incognita* eggs per gram of root were not significantly different among treatments. Sure-K+Micro-500 increased plant biomass over the control by 10%. The combination treatment: Sure-K+ Micro-500 was selected to be used in field trials due to viscosity concerns with Neptune's Harvest and reduced germination rates associated with Pro-Germinator.

Table 2A. Starter fertilizer effects on average soybean root and shoot fresh weight, plant biomass, *Meloidogyne incognita* total egg numbers, and eggs per gram of root at 45 DAP in greenhouse trials.						
					Meloidogyne incognita	
Treatment	Rate	Root fresh weight (g)	Shoot fresh weight (g)	Plant biomass (g)	Total eggs	Eggs/g root
Control	---	3.29 [y]	4.42	7.71	4637	1404
Sure-K™ [z]	9.28 L/ha	4.01	5.37*	9.39	5755	1505
ProGerminator™	4.64 L/ ha	3.91	6.44**	10.36**	5932	1505
Micro 500™	2.32 L/ ha	3.58	6.04**	9.63*	3787	1098
Neptune's Harvest™	7.41 L/ ha	3.81	5.79**	9.60*	6434	2307
Sure-K™ + Micro 500™	9.28 L/ ha + 2.32 L/ha	3.51	4.92	8.44	6728	1717
Pro-Germinator™ + Micro 500™	4.64 L/ ha + 2.32 L/ha	4.31	6.17**	10.48**	3634	848
Neptune's Harvest™ + Micro 500™	7.41 L/ ha + 2.32 L/ha	3.57	5.53**	9.09	4078	1147

[z]Fertilizers selected in these trials were Sure-K™ (2-1-6), Pro-germinator™ (9-24-3), Micro 500™ (B 0.02%, Cu 0.25%, Fe 0.37%, Mn 1.2%, and Zn 1.8%), and Neptune's Harvest (2-4-1).
[y] Means in the same column followed by * $P \leq 0.10$; ** $P \leq 0.05$ according to Dunnett's P values compared to the control are ssignificantly different.

<u>Nematicide Greenhouse Trials</u>

Nematicide and insecticide combinations greenhouse trials showed no significant benefit to plant biomass or shoot and root fresh weights at 30 DAP. Avicta, Cruisermaxx plus Avicta, ILeVO, and Poncho/VOTiVO plus ILeVO significantly reduced nematode eggs per gram of root by 91%, 87%, 74%, and 93% on average, respectively. The Avicta and ILeVO nematicides were chosen for implementation in field trials.

Table 3. Nematicide and insecticide effects on average soybean root and shoot fresh weight, plant biomass, *Meloidogyne inconita* total egg numbers, and eggs per gram of root at 45 DAP in greenhouse trials.						
					Meloidogyne incognita	
Treatment	Rate	Root fresh weight (g)	Shoot fresh weight (g)	Plant biomass (g)	Total eggs	Eggs/g root
Control	---	4.67	9.44	14.11	49955	11225
Cruisermaxx	88.72 mL/CWT	3.18	7.49	10.68	21785**	8457
Avicta	0.15 mg ai/seed	3.90	7.94	11.84	2735**	1323**
Cruisermaxx+ Avicta	+0.15 mg ai/seed	5.10	9.70	14.81	6026**	1323**
Poncho/ VOTiVO	0.13 mg ai/seed	2.45**	7.47	9.92**	36662	20114
ILeVO	0.15 mg ai/seed	3.00	7.88	10.89	5258**	1780**
Poncho/VOTiVO + ILeVO	0.13 mg ai/seed +0.15 mg ai/seed	3.35	8.53	11.89	2433**	664**

[z]Nematicides and fungicides selected in these trials were Cruisermaxx(1.25 g fludioxonil, 1.875 g mefenoxam, and 25 g thiamethoxam per 100 kg seed) Avicta (Abamectin), Poncho/VOTiVO (Clothiandin and *Bacillus firmus*), and ILeVO (fluopyram).
[y] Means in the same column followed by * $P \leq 0.10$; ** $P \leq 0.05$ according to Dunnett's P values compared to the control are significantly different.

Microplot Results

Microplot data demonstrated no statistical differences between treatments in biomass, root-knot nematode eggs per gram of root or yield in grams. Low nematode pressure in microplots did not separate treatments statistically. Avicta + Ascend IFS (in-furrow spray) produced 22% more yield than the control and supported 97% less nematode eggs per gram of root.

Table 4. Combination effects of plant growth regulators, starter fertilizers, and nematicides on cotton root fresh weight, plant biomass, and *Meloidogyne incognita* eggs per gram of root at 30 DAP in microplots.

Treatment	Rate	Shoot fresh weight (g)	Plant biomass (g)	*M. incognita* eggs/g root	Yield (g)
Control [Y]		49.92	59.96	1044	292
ILeVO ST	0.15 mg ai/seed	51.23	60.98	92	342
Avicta ST	0.15 mg ai/seed	62.71	76.79	26	320
Avicta +Sure-K +Micro-500 IFS	0.15 mg ai/seed +9.28L/ha	55.28	65.85	187	235
ILeVO + Sure-K +Micro-500 IFS	0.15 mg ai/seed +9.28L/ha	38.83	46.38	137	246
Avicta+ Ascend IFS	0.15mg ai/seed 233.7mL/ha	55.18	69.14	25	347
LeVO+ Ascned IFS	0.15mg ai/ seed 233.7m L/ha	57.49	70.01	22	299
Avicta+Sure-K +Micro-500 IFS +Ascend IFS	0.15mg ai/seed 9.28 L/ ha + 233.7m L/ha	50.55	61.64	17	246
ILeVO+Sure-K +Micro-500 IFS +Ascend IFS	0.15 mg ai/seed 9.28 L/ ha + 233.7 mL	48.53	59.26	124	342

[Y] Means in the same column followed by * $P \leq 0.10$; ** $P \leq 0.05$ according to Dunnett's P values compared to the control are significantly different.

Field Trial Results

PBU

Meloidogyne incognita population density at PBU was moderate to high during the growing season. Stand counts at 14 DAP were not statistically different among treatments thus the combinations of starter fertilizers, plant growth hormones and nematicides was not phytotoxic to the soybean seedlings. Root and shoot fresh weights, biomass and plant height were similar at 35 DAP. Avicta + Sure-K + Micro-500 significantly reduced *M. incognita* eggs per gram of root compared to the control at 35 DAP. Avicta + Sure-K + Micro-500+ Ascend IFS significantly increased yield over the ILeVO treatments. Tukey's mean separation demonstrated Avicta +Sure-K +Micro 500 + Ascend IFS was significantly greater in yield than ILeVO+ Sure-K+Micro-500 and ILeVO+ Sure-K+Micro-500+Ascend IFS. The combination of the plant growth regulator, starter fertilizers, and Avicta produced 7.3 bu/A or 13% more yield than the control and supported 38% less root-knot nematodes per gram of root than the control.

Table 5. Combination effects of plant growth regulators, starter fertilizers, and nematicides on cotton root fresh weight, plant biomass, and *Meloidogyne incognita* eggs per gram of root at 35 DAP and yields at PBU

Treatment	Rate	Shoot fresh weight (g)	Plant biomass (g)	*M. incognita* eggs/g root	Yield (Bu/a)
Control [Y]	---	34.80	43.89	2408	56.5 ab
ILeVO ST	0.15 mg ai/seed	36.63	45.16	921	51.2 b
Avicta ST	0.15 mg ai/seed	38.37	47.81	1064	57.5 ab
Avicta +Sure-K +Micro-500 IFS	0.15 mg ai/seed +9.28L/ha	40.81	50.75	801*	59.9 ab
ILeVO+ Sure-K +Micro-500 IFS	0.15 mg ai/seed +9.28L/ha	39.39	48.9	861	50.3 b
Avicta+ Ascend IFS	0.15mg ai/seed 233.7mL/ha	46.03	57.03	1115	55.1 ab
ILeVO+ Ascned IFS	0.15mg ai/ seed 233.7m L/ha	33.79	42.24	1259	51.7 b
Avicta+Sure-K + Micro-500 IFS + Ascend IFS	0.15mg ai/seed 9.28 L/ ha + 233.7m L/ha	38.72	48.59	1488	64.1 a
ILeVO+Sure-K + Micro-500 IFS + Ascend IFS	0.15 mg ai/seed 9.28 L/ ha + 233.7 mL	35.92	44.63	1133	49.3 b

[Y] Means in the same column followed same letter are not significantly different by Tukey's $P \leq 0.10$.

BARU

Meloidogyne incognita population density was low to moderate; average second stage juveniles per 100cc's were 21 across post-harvest soil samples. Stand counts were not significantly different at 14 DAP. No treatments were significantly greater than the control in plant biomass, shoot fresh weight, *M. incognita* eggs per gram of root, and yield. Avicta and Avicta+Surek-K+Micro-500+Ascend were significantly greater than ILeVO+ Sure-K+Micro-500 in plant biomass. Avicta and Avicta+starter fertilizer+ ascend were 38% and 21% greater in biomass than the control respectively. Avicta+Sure-K+Micro-500 was 6.7 bushels or 20% greater in yield than the control. Pearson's correlation coefficients demonstrated a significant, weak positive relationship between biomass and yield (0.34, $P \leq 0.05$).

Table 6. Combination effects of plant growth regulators, starter fertilizers, and nematicides on cotton root fresh weight, plant biomass, and *Meloidogyne incognita* eggs per gram of root at 38 DAP and yields at BARU					
Treatment	Rate	Shoot fresh weight (g)	Plant biomass (g)	*M. incognita* eggs/g root	Yield (Bu/a)
Control[X]	---	38.47 abc	47.05 abc	2.97 a	32.8 ab
ILeVO ST	0.15 mg ai/seed	35.26 bc	44.06 bc	2.17 a	32.9 ab
AvictaST	0.15 mg ai/seed	52.48 a	64.91 a	0.88 a	38.1 ab
Avicta +Sure-K +Micro-500 IFS	0.15 mg ai/seed +9.28L/ha	39.47 abc	47.99 abc	36.5 a	39.5 a
LeVO+ Sure-K +Micro-500 IFS	0.15 mg ai/seed +9.28L/ha	28.85 c	35.93 c	51.0 a	31.6 ab
Avicta+ Ascend IFS	0.15mg ai/seed 233.7mL/ha	36.79 abc	44.76 bc	30.1 a	34.1 ab
ILeVO+ Ascned IFS	0.15mg ai/ seed 233.7m L/ha	39.78 abc	49.10 abc	23.9 a	35.8 ab
Avicta+Sure-K +Micro-500 IFS +Ascend IFS	0.15mg ai/seed 9.28 L/ ha + 233.7m L/ha	46.14 ab	57.12 ab	2.21 a	34.4 ab
ILeVO+Sure-K +Micro-500 IFS +Ascend IFS	0.15 mg ai/seed 9.28 L/ ha + 233.7 mL	35.00 bc	42.76 bc	2.72 a	28.8 b
[X]Treatments followed by the same letter are not significantly different by Tukey's $P \leq 0.10$.					

Outcome: At PBU The Avicta nematicide combined with the Sure-K+Micro-500 starter fertilizer and the Ascend plant growth regulator in-furrow spray supported lower root-knot nematode populations while increasing yield by 7.3 bu/A. This yield increase, with a commodity price of $9.50/bu, will profit approximately $29.30/A after cost of treatments. The results at BARU demonstrated that Avicta combined with the Sure-K +Micro-500 treatment increased yields by 6.7 bushels or $35.65 after cost of treatments

III. Weed Management

Evaluation of Dicamba Tolerant Soybean Systems for Palmer Amaranth Control

J. Tredaway, A. Price, and D. Delaney

TREATMENTS:

Evaluation of Dicamba Tolerant Soybean Systems for Palmer Amaranth Control.			
	Treatment	*Rate*	*Timing*
1	Untreated Check		
2	2,4-D Amine+Roundup	24 fl oz + 32 fl oz	PRE
2	Prefix+Roundup	32 fl oz + 32 fl oz	E POST
3	2,4-D Amine+Roundup	24 fl oz + 32 fl oz	PRE
3	Clarity+Roundup	12 fl oz + 32 fl oz	E POST
4	2,4-D Amine+Roundup	24 fl oz + 32 fl oz	PRE
4	Clarity+Roundup	12 fl oz + 32 fl oz	L POST
5	Sharpen+Zidua+Roundup+MSO	1 fl oz + 2 oz + 32 fl oz + 1% V/V	PRE
5	Outlook+Engenia+Roundup	16 fl oz + 12.8 fl oz + 32 fl oz	E POST
6	Verdict+Zidua+Roundup+MSO	7.5 fl oz + 2 oz + 32 fl oz + 1% V/V	PRE
6	Outlook+Engenia+Roundup	16 fl oz + 12.8 fl oz + 32 fl oz	E POST
7	Clarity+Roundup	12 fl oz + 32 fl oz	PRE
7	Clarity+Warrant+Roundup	12 fl oz + 48 fl oz + 32 fl oz	E POST
8	Clarity+Rowel+Roundup	12 fl oz + 2 oz + 32 fl oz	PRE
8	Clarity+Warrant+Roundup	12 fl oz + 48 fl oz + 32 fl oz	L POST
9	Verdict+Zidua+Roundup+MSO	7.5 fl oz + 2 oz + 32 fl oz + 1% V/V	PRE
9	Engenia+Roundup	12.8 fl oz + 32 fl oz	L POST
10	Sharpen+Zidua+Engenia+Roundup+MSO	1 fl oz + 2 oz + 12.8 fl oz + 32 fl oz + 1% V/V	PRE
10	Outlook+Engenia+Roundup	16 fl oz + 12.8 fl oz + 32 fl oz	E POST

MATERIALS & METHODS:

This study was located at the Field Crops Unit of the E.V. Smith Research and Extension Center in Shorter, AL. This trial was conducted as a randomized complete block design with 10 treatments including an untreated check and 4 replications. This trial was established as a No-Till area. Pre-plant (PRE) applications were applied on June 2, 2016, and a window of 7-14 days was needed between this application and planting due to the inclusion of 2,4-D in some of the treatments. The soybeans were planted twelve days later on June 14, 2016. The Early Postemergence (EPOST) applications were applied on June 30, 2016, and the Late Postemergence (L POST) applications were applied on July 11, 2016. Weed control ratings were taken at planting, and a few days before the L POST application. The trial was harvested on September 28, 2016 with a harvested area of 6 x 25 ft.

RESULTS:

Weed control ratings were evaluated for % control of Palmer amaranth on a scale of 0-100%. In this study, every treatment gave us good to excellent control at planting. The treatments with three or more modes of action as a preemergence burndown received the highest % control whereas the treatments with just two modes of action such as the 2,4-D + Roundup or the Clarity + Roundup were evaluated in the 80-90% range. At 36 days after the early postemergence treatments we can see that the treatments with multiple modes of action and more residual components are able to have longer control. Whereas the treatments that just have the two modes of action discussed earlier are losing their ability to control the Palmer amaranth. However, when an early postemergence application was added to the treatments with just two modes of action, these treatments performed better as compared to the treatments that just received a PRE treatment with two modes of action.

Off-Target Academy for Field Demonstration and Field Days

J. Tredaway, C. Hicks, T. Sandlin, and K. Wilkins

TRIALS:
These trials were conducted at two locations. One was in North Alabama at the Tennessee Valley Research and Extension Center in Belle Mina, AL, and the other was conducted at the Plant Breeding Unit at E.V. Smith Research and Extension Center in Tallassee, AL. The demonstrations at the Plant Breeding Unit were showcased during the East Alabama Crops Tour on August 25, 2016, The demonstrations at Tennessee Valley were showcased during a crops tour conducted by Tyler Sandlin.

1. **Sprayer Clean Out Demonstration**

In this demonstration, a 50 gallon tractor sprayer was used to illustrate the importance of proper tank cleanout and the consequences of not cleaning your tank out properly after applying dicamba. To demonstrate this, we filled the tractor tank up with a full load and simulated spraying a field. After the sprayer sprayed for five minutes we drained the tank and went immediately to a field of regular Roundup ready soybeans. The sprayer was turned on and driven through the field. As you would expect, the first thirty feet where the application was made resulted in absolute plant death. After that initial plant death area the injury became less evident as you moved along. The tractor was then taken back up and the tank was dumped and refilled with a water and detergent solution for cleaning. The nozzles and screens were all taken off and cleaned in detergent water as well. The tractor was also sprayed off to ensure any dicamba that landed on the undercarriage or tires was removed as well. After the detergent was sprayed through lines it was then dumped and refilled again. This tank then went back to the field to spray the second pass. Very little injury was seen at this time, due to the detergent based clean. The tractor was then taken back up and dumped of this load and then refilled to rinse and spray out the lines a third time. This would simulate the Triple Rinse which is the correct way to clean a tank of dicamba. After the third rinse the tractor sprayer was filled again and taken back out to the field for the third spray. This time, there was no injury on the dicamba susceptible soybeans, which demonstrated that the triple rinse is the safest route when cleaning out your spray tank.

2. **Dose Response Demonstration**

In this demonstration, simulated drift rates were applied over the top of regular Roundup Ready Soybeans to show the different responses of susceptible soybeans to dicamba drift. The 1/10x rate killed the soybeans. The 1/100x rate knocked the meristem out of the top of the plant and it did not grow any bigger after the application. The 1/1000x rate early showed some leaf cupping and crinkling of the leaves at both timings. There was very little if any injury that occurred in the 1/10000x rate at either timing.

Simulated Drift Demonstration Treatment List			
	Treatment	*Rate*	*Timing*
1	Untreated	1/10X	V4
2	Engenia + NIS	1/100X	V4
3	Engenia + NIS	1/1000X	V4
4	Engenia + NIS	1/10000X	V4
5	Engenia + NIS	1/1000X	R2
6	Engenia + NIS	1/10000X	R2

1. **Auxin Tolerance Demonstration**

In the Auxin tolerance demonstration we applied the different auxin herbicides to show that you could not use different herbicide technologies interchangeably. Dicamba tolerant cotton can only tolerate Dicamba, and not the other auxins like 2,4-D, Enlist Duo, and Status. When these other auxins were sprayed on the dicamba tolerant beans it resulted in total plant death.

Auxin Tolerance Demonstration Treatment List		
	Treatment	*Rate*
1	Engenia	12.8 fl oz
2	2,4-D	22 fl oz
3	Status	5 oz
4	Enlist Duo	75 fl oz

2. **Weed Height Demonstration**

In the weed height demonstration, the applications were made every two to seven days to illustrate that the weed height at application has an effect on the weed control observed. The dicamba tolerant soybeans were around a week old when the first applications were made and then subsequent applications were made every week at Tennessee Valley and every 2-4 days at the Plant Breeding Unit. The targeted weed heights were 2, 4, 6, and 8 inches tall. As you would expect the taller the plants get the less they were able to control the growing weeds. Each treatment received the standard rate of Engenia which is 12.8 fl oz.

	Treatment	*Rate*	*Timing*
1	Untreated		
2	Engenia	12.8 fl oz	2 inches
3	Engenia	12.8 fl oz	4 inches
4	Engenia	12.8 fl oz	6 inches
5	Engenia	12.8 fl oz	8 inches

Evaluation of Residual Soybean Herbicides for Palmer Amaranth Control in Soybeans

J. Tredaway, A. Price, and D. Delaney

TREATMENTS:

Evaluation of Residual Soybean Herbicides for Palmer Amaranth Control in Soybeans			
	Treatments	*Rate*	*Timing*
1	Untreated Check		
2	Valor SX + Dual Magnum	2 oz + 16 fl oz	PRE
2	Prefix + Roundup	32 fl oz + 32 fl oz	POST
3	Surveil	2.1 oz	PRE
3	Prefix + Roundup	32 fl oz + 32 fl oz	POST
4	Fierce	3 oz	PRE
4	Prefix + Roundup	32 fl oz + 32 fl oz	POST
5	Rowel FX	3 oz	PRE
5	Prefix + Roundup	32 fl oz + 32 fl oz	POST
6	Warrant Ultra	48 fl oz	PRE
6	Prefix + Roundup	32 fl oz + 32 fl oz	POST
7	Authority MTZ	14 oz	PRE
7	Prefix + Roundup	32 fl oz + 32 fl oz	POST

MATERIALS & METHODS:

This study was conducted at the Plant Breeding Unit of the E.V. Smith Research and Extension Center in Tallassee, AL. This trial was initiated as a conventional tillage operation with 7 treatments including an untreated check and 4 replications in the randomized complete block design. The trial was planted on June 9, 2016, and the preemergence applications were applied later that day. An early post application of Prefix + Roundup was applied to each plot except for the untreated checks. Ratings were evaluated a month after the early postemergence application.

RESULTS:

Regardless of the system used, the PRE + POST system controlled palmer amaranth and carpetweed at 28 days after planting. It provided good residual, however, it was planted behind a wheat crop with a lot of stubble. I would like to continue this study on conventional soil and see how the systems compare.

IV. Disease Management

Population Surveillance in Alabama of the Fungus that Causes Soybean Sudden Death Syndrome

J. Coleman, L. Wendell, E. Sikora, and K. S. Lawrence

The objectives of this project was to 1) survey field isolates that are responsible for causing soybean sudden death syndrome [*Fusarium virguliforme*] in Alabama and 2) begin to investigate the genetic variability of these field isolates.

RESULTS: Identifying and understanding the genetic diversity within the population of *F. virguliforme* isolates in Alabama is important for implementing an effective disease management strategy without inadvertently selecting for more virulent strains of the fungi.

Of the fungal isolates collected this past season, none were identified as *F. virguliforme*, the causative agent of sudden death syndrome (SDS). In relation to this study, isolates were obtained from a commercial field in northern Alabama with reports of plants displaying the characteristic foliar symptoms of SDS and water soaking of the vascular system near the stem. Isolation of the fungi from the vascular system of infected plants revealed it was due to an isolate of *F. solani*, although not *F. virguliforme*. Molecular identification of the isolate by sequencing two loci (ITS and elongation factor 1α) revealed it belonged to the currently unnamed phylogenetic species FSSC 5. Currently it is unknown how prevalent isolates of FSSC 5 are in causing disease on soybean in Alabama, but culture collections from diseased soybean fields in the north central US in 1991 and 1995 indicated FSSC 5 was the predominant species of FSSC (Chitrampalam and Nelson Jr, 2016).

As with previous growing seasons, a number of *F. oxysporum* isolates were obtained from diseased soybean plants. Molecular typing of these isolates showed these isolates were phylogenetically similar to *F. oxysporum* isolates obtained from diseased cotton fields in Alabama. While it has been well established that a single isolate of *F. oxysporum* can cause disease on both soybean and cotton, identification of several examples may indicate that these isolates are common in Alabama. Therefore, field rotations between these two crops may not be an effective management strategy for *F. oxysporum*.

Evaluation of Fungicides for Control of Soybean Rust and Other Foliar Diseases of Soybeans

D. Delaney, E. Sikora, and K. S. Lawrence

The objective of this project was to evaluate multiple fungicides for control of soybean rust and other foliar diseases in Alabama.

Results:

Fungicide trials for the control of soybean rust (SBR) and other foliar soybean diseases were established at five Experiment Stations around the state.

Fungicide trials were conducted at Tennessee Valley and Sand Mtn RECs, as well as at EV Smith and Plant Breeding Unit, as well as several at the Gulf Coast REC, for a total of 10 trials. Different trials included different fungicide products and timing and varieties. Some trials were irrigated, while most were dryland.

Several trials were late planted due to early season wet weather and also intentionally to increase exposure to soybean diseases, however, late summer dry weather at several locations limited disease pressure. Due to hot and dry periods in mid-summer, SBR was late starting to spread across the state. Frogeye leaf spot was common in some trials and Alabama soybean fields in 2016, however late summer dry weather limited foliar disease development.

Ratings were taken wherever sufficient disease and harvest green stem was present. Ratings were made for SBR and Cercospora Leaf Blight at Gulf Coast REC, SBR at Sand Mtn, frogeye leafspot at TVREC, and Cercospora Leaf Blight at EV Smith.

At Sand Mtn REC, a Variety * Fungicide Timing trial led to significant differences for both Varieties and Fungicide Timing for SBR, leaf defoliation, and yield, although Varieties or Fungicide applications did not have a significant effect on green stem. The R3 application of a strobilurin fungicide Headline @ 6 fl oz/A) significantly increased yield by 3 bu/A compared to the Untreated Check and R5 application (65.7, 62.5, and 62.1 respectively).

The same trial at Plant Breeding Unit had no significant disease pressure, and no significant differences in yield or green stem for Variety or Fungicide Timing.

Due to late harvests on most tests, data from ratings, green stem, yield, and 100-seed weights are still being analyzed and will be presented later.

Evaluation of Fungicide Programs with Large-Scale Strip Tests

E. Sikora and D. Delaney

Six large-scale fungicide strip trials were established at Auburn University research stations to determine the benefit of fungicide applications in soybean production. Trials varied slightly by location but each included an unsprayed control plus single applications of Topguard, Folicur, Priaxor, Quadris Top SB, and/or Stratego YLD. Each trial had a minimum of three treatments and three replications.

Even with the dry conditions from July through October across the state, we still observed significant disease development at five of the six trial locations. Soybean rust appeared at Fairhope, Brewton, Headland and Shorter, and differences were observed between the unsprayed control and the fungicide treated plots. Yield differences between these treatments were not as great as expected due to the negative impact of the drought and most locations. Frogeye leaf spot appeared in the trial at Bell Mina and disease ratings were taken in late August, but unfortunately, drought conditions caused the field to senesce prematurely and a second rating could not be recorded. The same situation occurred at Crossville where no disease was observed before the field dried down prematurely in September. Yield data and disease ratings have not been analyzed at the time of this report.

In previous years we have seen a benefit from timely fungicide application for disease control. The benefit of a fungicide application is dependent on its timing, with applications made prior to disease onset more effective at protecting the yield potential of the crop. In years when weather conditions do not favor disease development there is rarely a benefit from a fungicide application.

Trial locations	**Plant diseases observed**
Bell Mina	Frogeye leaf spot
Brewton	Soybean rust
Crossville	No disease - DROUGHT
Fairhope	Soybean rust and Cercospora leaf blight
Shorter	Soybean rust
Headland	Soybean rust

Determining if Soybean Vein Necrosis Virus Causes Yield Loss in Soybeans

E. Sikora, A. Jacobson, K. Conner, J. Kemble, D. Delaney and J. Murphy

Soybean vein necrosis virus (SVNV) has been detected in 31 counties in Alabama since 2012. It is unclear whether SVNV causes significant yield loss in commercial soybean fields. The objective of this study is to determine if SVNV causes yield loss in soybeans. The experiment was conducted at the Tennessee Valley Research & Extension Center in Bell Mina and the Wiregrass REC at Headland. The replicated trial used row covers to prevent thrips feeding and virus transmission from planting through the first 6, 8, or 10 week period of the growing season. Populations of migrating thrips were monitored, SVNV incidence was determined periodically, and yield and seed quality were determined after harvest.

Results: Poor seed quality and low germination led us to replant the test at both locations. At TVS, row covers did an acceptable job of keeping thrips out of the treatments, but once removed insects quickly migrated to the unprotected plants. The majority of thrips captured during the test at TVS were soybean thrips, a known vector of SVNV. Incidence of SVNV was sporadic among the treatments during the season, possibly due to the uneven stands. Drought conditions at TVS late in the season made it difficult to collect disease incidence or severity at crop maturity. Yields were relatively low at TVS, though treatments with row covers had significantly higher yields than the two control treatments. Symptoms of SVNV were not observed at Wiregrass, a location where the disease had not been reported previously. There were no significant difference in yield at this location, possibly due to the fact is was overhead irrigated during the season.

Table 1. Row cover/SVNV effect on yield at TVS and Wiregrass, 2015 and 2016

TREATMENT	Yield bu/acre		
	TVS-2015	TVS-2016	Wiregrass-2016
Check – uncovered	76.2 d	22.2 b	69.3 a
Insecticide – uncovered	79.4 c	21.6 b	70.1 a
Row cover - 6 weeks	80.4 c	35.9 a	76.6 a
Row cover - 8 weeks	84.4 b	34.7 a	71.1 a
Row cover - 10 weeks	89.5 a	36.3 a	76.2 a

Using Unmanned Aerial Systems for Early Detection of Soybean Diseases

E. Sikora, C. Brodbeck, G. Pate, D. Delaney, and A. Hagan

In 2016, a preliminary study was launched to examine the potential of using aerial imagery from UAS to detect diseases in soybean crops. Two irrigated fields in Alabama were selected, Experiment 1, a 125-acre field, and Experiment 2, a 12-acre field. Each trial consisted of replicated plots using two foliar fungicide treatments and an untreated control. Aerial imagery (multi-spectral and true-color) was collected on a biweekly basis during this study.

Using multi-spectral imagery, both the Normalized Difference Vegetative Index (NDVI) and Normalized Difference Red Edge Index (NDRE) were generated and compared to direct observations in the field. Disease severity of soybean rust, charcoal rot and Cercospora leaf blight were monitored on a biweekly basis and correlated to the UAS imagery.

Preliminary results indicated plant stress can be detected using UAS imagery. In Experiment 1, stress associated with charcoal rot was visible in the NDRE imagery. This was of interest because at the time of flight, while it was noted that plants were yellowing, the root and stem disease itself had not been identified by direct observation. In Experiment 2, soybean rust was observed by direct observation and in both the NDRE and NDVI imagery. Soybean rust did have a negative impact on yield in experiment 2, however severe drought conditions may have negated the yield loss likely caused by the development of charcoal rot in Experiment 1. During year one, it was demonstrated that UAS, used with a multi-spectral camera, could be used to detect disease in soybeans, and possibly supplement in-field scouting for soybean rust. Disease detection was conducted by assessing variability and identifying either irregular patterns, or patterns that followed the treatments in the study. While much of the variability detected was due to disease, some of the variability could be attributed to rapid crop maturity as a result of the unusually hot, dry weather experienced during the growing season. While UAS is an excellent tool for generating vegetative indices to determine field variability, having a working knowledge of the field, weather patterns, crop stages and management practices is critical for understanding the observed variability.

Determining the Relationship of Soybean Vein Necrosis Virus with Morning Glory and other Weeds in Soybean Fields in Alabama

E. Sikora, K. Conner, L. Zhang and D. Monks

Soybean vein necrosis virus (SVNV) was first found in Alabama in Limestone County in 2012. Characteristic symptoms of the disease include brown necrotic blotches along major veins of the upper and lower leaf surface, resulting in a scorched appearance of damaged leaves. Previous studies have reported that morning glory (MG) is a symptomless host of SVNV and can act as a source of inoculum for soybean fields. Since 2012 SVNV has been detected in 31 counties in Alabama. Incidence of the disease within a field is typically highest in North Alabama with some fields approaching 100% infection.
In the first year of this project (2014), leaves were collected from MG populations growing adjacent to soybean fields showing symptoms of SVN. Of the seven populations of MG screened for SVNV, only one tested positive for the virus. This MG population was growing next to a soybean field that had 100% incidence of the disease. Incidence of SVNV in adjacent fields to the six MG populations that tested negative for the virus ranged from 4-50%.

In 2015 leaves were collected from MG populations growing adjacent to soybean fields in nine locations. In each case none of the MG plants tested positive for SVNV. Incidence of SVNV incidence typically ranged from 45-85% in soybean fields adjacent to the nine MG populations. Our inability to detect SVNV in the MG population suggests that MG is a poor host in nature for the virus.

In addition to screening populations of MG, we also tested other weed species growing near fields with a history of high levels of SVN incidence. These weeds were collected in the spring of 2015 prior to planting of soybeans, or in the fall after soybeans had senesced in the field. We suspected these weeds could act as overwintering or "bridge" hosts for the virus and play a role in the disease cycle of SVN. Weeds collected and tested included English plantain, white clover, large yellow vetch, Virginia pepperweed, sheperd's purse, Maypop passionflower, field pepperweed, wheat, false garlic, wild carrot, Carolina geranium, curly dock, buckhorn plantain, deadnettle, henbit, golden ragwort and hairy bittercrest. Number of weeds collected and tested varied over three sampling dates but typically ranged from 10-20 specimens of each species. All weeds tested negative for the presence of SVNV.

The objective of this study is to establish the importance of MG and other weeds found near soybean fields to determine their role in the disease cycle of SVNV. In 2016 we will continue to tests weeds adjacent to soybean field looking for alternate hosts of SVNV.

Building a Disease-Related Gene Expression Catalog that Can Be Used for Disease Diagnosis and Genetic Improvement

R. D. Locy, E. Sikora, and K. Conner

Our initial objective was to establish a database of molecular responses made by soybean roots and leaves to soil-borne pathogens. To accomplish this we initially collect samples from the field of plants apparently infected with charcoal rot and root knot nematode. However, it was apparent that field collected samples were not appropriate for this initial goal while they will be necessary to establish the utility of the information we initially need to collect. Consequently, we grew plants in the greenhouse and infected the greenhouse grown plants with either root knot nematode (RKN) or soybean cyst nematode (SCN). Five replicates of root and leaf tissue were collected 2, 5, 10, and 20 days post infection, and control (uninfected) plants were also collected at each of those time point. For RNA sequencing, total RNA was prepared from composite samples of control, RKN-infected, and SCN-infected. Thus, there were 5 replicates of control, RNK-infected and SCN-infected either roots or leaves. Each sample consisted of 2, 5, 10 and 20 day infected tissue mixed in equal quantity. RNA was prepared by the triazole method, and is currently being sequenced at the Hudson-Alpha Institute for Biotechnology in Huntsville, AL.

Once the samples have been sequenced the expression of all mRNAs in each sample will be determined by bioinformatic analysis using the Trinity gene assembly software to determine the level of expression of all mRNAs in each treatment. Once accomplished, the expression of multiple differentially expressed gene will be verified separately in all 5 replicates, using Quantitative PCR. Once the analysis is complete, the data will be made available at the NCBI web site, and published to make it available to other plant pathologists interested in the pathogens we are working with.

V. Insect Management

On-farm Demonstration of Low-input Biological Control for Suppressing Populations of Kudzu Bugs in Soybean

X. P. Hu and T. Reed

This project is to validate previous finding that the specialist braconid wasp, *Paratelenomus saccharalis*, has significant impact as a control agent for kudzu bug in soybeans, through field trials to determine whether or not pesticide sprays are necessary when kudzu bug is at or above the recommended threshold but their eggs are highly parasitized by this wasp; and at what parasitism rate a pesticide spray is needed.

This project was conducted at Prattville Center, not the proposed William Griffiths' Farm. This change is to adjust the cost of travel and operation, because we were awarded half of the proposed budget. Pioneer 95Y70 was planted on May 15, and Progeny 5555 was planted on June 15, 2016. Plots were 8 rows wide and 30 feet long. Rows were 36 inch spacing.
Treatments: The early-planted soybean had 2 insecticide treatments and 1 unsprayed control treatments with 3 replicates per treatments at random block design (RBD). The late-planted soybean had 1 insecticide treatment and 1 unsprayed control with 3 reps per reatment at RBD.

Insecticide Brigade (Bifenthrin) was sprayed on soybean plants R2 stage using hand-sprayer at 20 gal/acre, because the number of kudzu bug adult/nymph reached 4 per net sweep and egg parasitism rate (visual count) was lower than 50% when soybean was at R1. An additional spray was applied 2-4 week after R2 because the survey indicated that the # kudzu bug and parasitism rate remained the similar levels.

Additionally, we surveyed the entire soybean field at the Center to assess the correlation of kudzu bug infestation between broad-leaf and large-seeded vs. narrow-leaf and small-seeded soybean.

Results:

1. The numbers of kudzu bug adult/nymph per sweep and egg-parasitism rate at R5 were presented in Table 1.

Table 1. Efficacy of different treatments in controlling kudzu bug in soybeans, Prattville, AL 2016)

Soybean		2 spray (R2, 3-wk after R2)	1 spray (R2)	No spray	P value
	# of KB	3.5 a	4.2 a	15.6 b	< 0.001
	Egg parasitism rate (%)	52 a	76 a	67 a	0.52
	# of KB	--	2.8 a	3.1 a	0.762
	Egg parasitism rate (%)	--	34 a	41 a	0.03

2. Kudzu bug population estimates correlated with soybean-plant biological characters are presented in table 2.

Table 2. Correlation of kudzu bug population between soybean varieties at R5 of different biological characters (unknown planting dates, insecticide spray history and variety names)

Broad-leaf, large-seeded	H (> 6 adult/nymph per sweep)
narrow-leaf and small-seeded	L (< 6 adult/nymph per sweep)

From the data, we draw the follow preliminary conclusions:

1. Early-planted soybean: 1 spray at R2 stage reduced kudzu bug numbers by 4-fold compared with control. The spray was applied at R2 if egg-parasitism rate at R1 was < 50% and kudzu bug was ≥4 adult/nymph per sweep. An additional spray was necessary 2wk after if the rate remained <50% and kudzu bug # ≥4 adult/nymph per sweep.
2. Spray after R5 didn't further knock down kudzu bug number because *Beauveria* infection is high
3. Late-planted soybean: No difference in kudu bug # between one spray at R2 and no-spray.
4. Broad-leaf, large-seeded soybeans had higher kudzu bug infestation than narrow-leaf and small-seeded varieties

We expect to continue this work for another 2 years to validate the results and be able to demonstrate the same results on private farms.

Impact of The Parasitic Wasp *Paratelenomus saccharalis* in Suppressing Populations of Kudzu Bugs Infesting Soybeans in Alabama

T. Reed and X. P. Hu

This study was to understand the impact of kudzu bug (KB) egg parasitoid, *Paratelenomus saccharalis*, on kudzu bug populations affecting soybeans in Alabama, measured by egg parasitism rates. This wasp was first discovered by us in a soybean plot at AU in June 2013. The parasitization rate dramatically went up from about 10% in June to about 80% when soybeans grew into R6 stage. We initiated this project in 2014, and are generating valuable data to enable us a comprehensive understanding of the impact and future potential of this wasp in keeping KB level under damage threshold.

The wasp parasitoid rates were monitored at four AU research stations. Soybeans were planted between April and late May. Wasp parasitism data were collected from 10 plots at 4 locations: 3 plots at Prattville, 3 at Brewton, 3 at EV Smith, and 1 on AU campus. Plot sizes varied between 4 – 12 rows. All the plots were insecticide sprayed, except for 1 plot in Prattville and 2 plots in Brewton, and the one on AU campus that were unsprayed as control. Egg-masses were surveyed on plants 6 times during the growing season from July 1 through September 2016. Twenty 20 egg-masses were examined per plot, making a total of 4,800 egg-masses.

Additionally, to have a better understand about how widely distributed this wasp is in Alabama, we extended the survey to include 42 Alabama counties in 2016. Soybean fields and kudzu patches were visually surveyed.

RESULTS:

Table 1. Mean parasitism rate (%) of kudzu bug egg-mass by *Paratelenomus saccharalis*

Location	Plot	07/02	07/19	07/27	08/05	08/15	08/26	09/05
	A-1	0	0	14.29	9.53	85.71	61.90	61.91
	A-2	0	4.76	19.05	28.5	76.19	95.24	66.67
	A-3	0	0	23.81	42.86	52.38	66.66	71.43
	Average	**0**	**1.59**	**19.05**	**26.98**	**71.43**	**74.60**	**66.67**
	B-1	4.76	4.76	57.14	52.38	71.43	100	92.86
	B-2	0	4.76	47.62	71.43	80.95	95.24	95.24
	B-3	0	0	38.10	85.71	43.19	100	-
	Average	**1.59**	**3.18**	**47.62**	**69.84**	**65.19**	**97.96**	**94.28**
		07/02	07/19	07/27	08/05	08/15	08/26	09/08
	C-1	0	9.53	33.33	19.05	100	85.71	-
	C-2	0	0	4.76	28.57	42.86	71.43	-
	C-3	0	0	14.29	47.62	90.47	71.43	-
	Average	**0**	**3.18**	**17.46**	**31.75**	**77.78**	**76.19**	**-**
		07/02	07/19	08/01	08/08	08/16	08/26	09/08
	D-1	0	0	57.14	66.67	76.19	-	-
	D-2	0	0	4.76	52.38	81.62	61.91	85.71
	Average	**0**	**0**	**30.95**	**59.52**	**78.90**	**61.91**	**85.71**

Table 2. Number of Kudzu bugs on 5 soybean plants (adults in black and nymphs in red)

Location	Plot	07/02	07/19	07/27	08/05	08/15	08/26	09/05
	A-1	3.75	30.75	16.50	47.50	1.50	2.50 0.50	3.50
	A-2	0	2.25	7.75	38.50	5.75	8.75 0	0.50
	A-3	0	8.50	11.50	6.00	0.50 12.50	6.00 0	0.75
	Average	**0**	13.83	11.92	30.67	2.58	5.75 0.17	1.58
	B-1	21.75	15.75	9.25 28.00	9.50 70.00	29.75 47.75	64.25	40.25
	B-2	13.75	6.00	4.25	6.75 10.75	2.00 16.25	4.00 4.00	3.00
	B-3	5.50	4.00	8.75	8.00	3.50	2.75 3.25	0.50
	Average	13.67	8.58	7.42	8.08	11.75 21.33	23.67 2.42	14.58
		07/02	07/19	07/27	08/05	08/15	08/26	09/08
	C-1	0	8.00	6.50	0.50	1.50	1.50 0	1.75 1.75
	C-2	0	13.50	4.50	8.00	3.75	0.50 12.50	2.25
	C-3	0	23.00	7.00	4.25	3.50	2.25 22.75	1.00
	Average	**0**	14.83	6.00	4.25	2.92	1.42 11.75	1.67 0.58
		07/02	07/19	08/01	08/08	08/16	08/26	09/08
	D-1	0.25	12.25	22.25	16.25	6.25	-	-
	D-2	0	13.50	21.50	15.75	12.50 13.50	35.75 42.90	78.50 78.50
	Average	0.13	12.88	21.88	16.00	9.38	35.75 42.90	78.50 78.50

Conclusion and Discussion

The egg parasitism rates showed a similar seasonal pattern at the 4 locations, which were increasing parasitism rates starting in early July and peaking in late August. No significant difference in parasitism rates were detected between locations, as well as between treated plots and unsprayed plots. However, control plots had higher rate in early season than treated plots.

The kudzu bug populations: Brewton had greater kudzu bug infestation than Prattville and EV Smith centers, but no substantial difference between treated and control plots as well.

The two data sets look unreasonable, but consider the plots were not far from plots other researchers were testing. There might have been heavy drift of pesticide from adjacent plots and that influenced the target populations in our slots.

Interesting is the plots on AU campus, that were used for herbicide plus seed treatment test had not been sprayed for 2 years. After two years of high parasitism and low KB infestation, the wasp parasitizing rates were lower this year. There was a surge of KB population in later August, because of the cleaning of surrounding host plants, not contributed to low wasp rate.

Supplemental Table. Soybean Plot Locations and Information (2016):

Location	Plot	Soybean Variety	Insecticide spray	Planting Date	Size
	A-1	AG54X6	Brigade on 6/8, 7/15 and 7/26	05/10/16	12 rows
	A-2	Pioneer 95Y70	Brigade on 6/8, 7/15 and 7/26	05/23/16	8rows
	A-3	ASGROW 5935	none	04/29/16	4 rows
	B-1	Pioneer 94Y70RR	none	04/29/16	8 rows
	B-2	Pioneer54T94R	none	05/11/16	8 rows
	B-3	Pioneer P76T54R2	Fungicide in Aug	06/05/16	12 rows
	C-1	Pregeny5555	Karate on 6/9, Strategoyld (fungicide) on 8/17	05/26/15	12 rows
	C-2	Pregeny5555	Herbicide spay before planting, fungicide STRATEGO YLD spray on 8/17	05/25/16	12 rows
	C-3	Progeny 70310R	Herbicide spray before planting, fungicide STRATEGO YLD spray on 8/17	05/25/16	8 rows
	D-1	Pioneer 93Y92	Seed treatment with addition Roundup PowerMax (glyphosate), Dual Magnum	04/27/16	8 rows
	D-2	Asgrow 5831	Seed treatment with addition Roundup PowerMax (glyphosate), Dual Magnum	06/15/16	8 rows

Beauveria bassiana as a control agent for kudzu bug in soybean

A. Jacobson, K. Conner, E. Sikora, D. Delaney, M. Delaney, and C. Ray

The number of kudzu bugs that result in economic yield losses is unknown, however, last year in small plot trials, kudzu bug infestations did not result in yield loss compared to insecticide treated plots. In the last 3 years a naturally occurring fungus has reduced kudzu bug populations, and may be suppressing populations to a level that no longer warrants insecticide applications. This study was conducted to examine whether or not yield reductions occurred in soybean plots infested with *Beauveria bassiana* infected kudzu bugs. Small plot field trials established in Brewton, Prattville, Shorter, and Headland included early- and late- plantings, and insecticide-treated and non-treated plots in each planting date. Kudzu bug infestations were monitored weekly throughout the growing season, and the number of bugs infested with fungus were counted.

In 2015, in Prattville and in Auburn, the number of kudzu bugs per drop cloth sample ranged from 50-200 the second half of August. In 2016, kudzu bug numbers never exceeded 20 in any sample taken during the growing season at these 4 locations. Therefore, a meaningful comparison of yield in infested and uninfested plots could not be made. There were still reports of kudzu bugs occurring in some growers' fields in 2016, however, the level of infestations in these locations was not well communicated. This next year populations of kudzu bug may remain low, or may rebound if populations are able avoid fungal infections. Continued monitoring of kudzu bugs and the prevalence of *Beauveria* in kudzu populations will provide information about the long-term impacts of this fungus on the kudzu bug in Alabama.

The Brown Marmorated Stink Bug

T. Reed

Materials and Methods

Test 1: Test plots to assess brown marmorated stink bug (BMSB) affect on the stink bug complex threshold in soybeans and the effect of border sprays were planted along the northeastern edge of the Prattville ARU on May 23 using the variety Pioneer 95Y70. Plots were 8 rows wide and 30 feet long and were arranged in a RCB design. There were two bifenthrin treatments applied on 9/02 and 9/06 and the unsprayed treatment. Plots were sampled on 9/08 and 9/22 using a 15 inch- diameter sweepnet and making 10 sweeps across two rows in each plot.
Test 2: Another test was conducted to assess the effect of planting date on BMSB density and gain economic threshold information. Plots (16 rows by 30 ft long) were planted on 4 different planting dates (5/10, 5/23, 6/14 and 6/29 and were sampled on 6 dates between 6/24 and 9/02. 8 rows in each plot were sprayed 3 or 4 times with bifenthrin to reduce stink bug numbers. Yields were taken at plant maturity.
Test 3: The third test was planted on on 8/19 to determine the movement pattern of BMSB's and other stink bugs into late-planted soybeans. The one acre plot was sampled along the east and west edges and in the middle of the plot on 2 sampling dates.

Results: (Test 1) Ten sweepnet samples taken in the test plots on 8/18 (plants in late R5 stage) did not detect any BMSB's present. Southern green stink bugs were present at a density of 0.4 per 10 sweeps. Kudzu bugs were present at a density of 161/10 sweeps with over 90% being adults. After plots were sprayed on 9/2 and 9/6 sweepnet counts taken on 9/08 showed a low density of 0.25 BMSB's per 10 sweeps in the untreated plots and a total stink bug density of 3.9/10 sweeps (Table 1). SGSB's and brown stink bugs comprised 93% of the stink bug population. Sweepnet samples taken on 9/22 showed the same density of BMSB's and fewer numbers of other stink bugs in untreated plots (Table 2). Bifenthrin reduced kudzu bug numbers by an average of 97% by 9/08. There was no significant difference among the 3 treatments with respect to yield which ranged from 26.9 bu/acre in the untreated plots to 28.3 bu/acre in one bifenthrin treatment.
Test 2: Sweepnet samples taken in soybeans planted on 4 different dates showed that BMSB numbers did not increase in any plots until 8/17 when numbers increased from 0.375/10 sweeps on 8/03 to 2.3/10 sweeps on planting date (PD) 1. The following week numbers increased again to 2.6/10 sweeps. BMSB numbers did not exceed 0.4/ sweep in any other planting date treatment. Spraying the soybeans did not impact yields in part because the stink bugs moved into the beans after the July 26 spray. PD1 soybeans were in the R5.6 stage on 8/17.
Test 3: No BMSB's were collected in the one acre plot of late planted soybeans. Red banded, Red shouldered, and southern green stink bugs were collected in the late planted field on 10/05 and 10/25 after pod formation. However, BMSB's were still present in the PD1 plots in Test 2 on 10/5. This may indicate that under test conditions the BMSB's may have moved to overwintering sites in October once their host soybeans matured.

Effects of Neonitinoid Seed Treatments and Foliar Sprays on 3-cornered Alfalfa Hoppers and Other Insects Infesting Soybean in 2016

T. Reed

Materials and Methods: This study was conducted at the Brewton and Prattville Agricultural Research Unit. Treatments were arranged at both stations in a factorial design with the variables tested being insecticide seed treatments { (1) Cruiser, (2) Gaucho, (3) Poncho and (4)Untreated with fungicide only} and foliar insecticide sprays { (1) Belay 2.13 @ 6 oz/acre, (2) Brigade 2 @ 6.4 oz/acre (3) Centric 40WG @ 2.5 oz/acre (4) Admire Pro 4.6 @ 1.7 oz/acre and (5) No Foliar Spray}. Liberty Link soybeans were planted May 4, 2016 at Brewton and at Prattville on June 22 using a 36 inch row spacing. Foliar sprays were applied June 9 at Brewton in 20 gallons of water per acre using John Deere PSL DAQ 1002 nozzles and 30 psi. Foliar sprays were applied Aug 4 at Prattville using TX 6 conejet nozzles that delivered 8.5 gallons of water per acre using 50 psi. There were 4 replications for each seed treatment X foliar spray combination. Plot size for each combination was 8 rows wide X 25 feet long. Plots were sampled for 3-cornered alfalfa hoppers (3CAH) and kudzu bugs (KB) using a 15 inch diameter sweep net and ten sweeps across two rows were made in each plot each sampling date. Rows 2 and 3 and 6 and 7 were sampled each sampling date. Sampling dates at Brewton were 5/24, 6/23, 7/12, and 8/03. Sampling dates at Prattville were 8/03 and 8/17.

Results - Brewton: Numbers of 3CAH were low in this study with the highest recorded density for any treatment on any sample date was 3.1 per 10 sweeps. There was no significant seed treatment effect with respect to the number of 3CAH's collected on the first 3 sampling dates (Table 1). However on the 8/03 sampling date there were significantly fewer 3CAH's in the fungicide- only treatment than in the Gaucho and Poncho treatments. There was no significant foliar treatment effect with respect to the number of 3CAH's on any sampling date (Table 2). KB numbers were well below the economic threshold level. There was no significant seed treatment effect with respect to the number of KB's collected on any sampling date or on yield (Table 3). There was no significant foliar spray treatment effect on the first 2 sampling dates with respect to numbers of KB's sampled nor on yield (Table 4). However, on the 8/03 sampling date there were significantly fewer KB's in the untreated plots than in any insecticide- treated plots.

Table 1. Mean number of 3-cornered alfalfa hoppers per 10 sweeps in soybeans planted May 4 and receiving different neonicotinoid seed treatments. Brewton, AL 2016

	Number Per 10 Sweeps			
Seed Treatment	5/24	6/23	7/12	8/03
Fungicide only	1.4	1.9	1.4	1.9 C
Gaucho	1.2	2.1	1.4	2.9 AB
Poncho	1.1	1.4	1.5	3.1 AB
Cruiser	1.6	1.4	1.2	2.3 BC
P>F =	0.52	0.33	0.95	0.04
LSD 0.1 =	---	---	---	0.73

Table 2. Mean number of 3-cornered alfalfa hoppers per 10 sweeps in soybeans receiving different neonicotinoid or pyrethroid foliar sprays on June 9. Brewton, AL 2016

Number Per 10 Sweeps				
Foliar Treatment	5/24	6/23	7/12	8/03
Untreated	1.3	1.9	1.4	3.0
Admire Pro 1.7 oz/acre	1.6	2.1	1.6	2.1
Centric 2.0 oz/acre	0.6	1.4	0.8	2.0
Belay 6 oz/acre	1.5	1.4	1.3	3.1
Brigade 6.4 oz/acre	1.6	1.6	1.6	2.5
P>F =	0.16	0.48	0.37	0.11

Table 3. Mean number of Kudzu Bugs per 10 sweeps and yields in soybeans planted May 4 and receiving different neonicotinoid seed treatments. Brewton, AL 2016

Number Per 10 Sweeps					
Seed Treatment	5/24	6/23	7/12	8/03	Bu/Acre
Fungicide only	0	4.8	5.1	20.0	55.0
Gaucho	0	6.0	4.7	15.3	56.4
Poncho	0	5.2	4.2	15.2	54.4
Cruiser	0	6.3	4.5	18.4	52.7
P>F =	---	0.33	0.95	0.33	0.43

Table 4. Mean number of Kudzu Bugs per 10 sweeps and yields in soybeans receiving different neonicotinoid or pyrethroid foliar sprays on June 9. Brewton, AL 2016

Number Per 10 Sweeps				
Foliar Treatment	6/23	7/12	8/03	Bu/Acre
Untreated	6.1	4.8	8.9 C	57.9
Admire Pro 1.7 oz/acre	6.2	4.6	24.0 A	54.6
Centric 2.0 oz/acre	5.3	5.9	23.9 A	54.5
Belay 6 oz/acre	5.6	3.4	16.6 B	54.3
Brigade 6.4 oz/acre	4.5	4.3	12.4 BC	51.8
P>F =	0.48	0.37	0.0001	0.22
LSD 0.1 =	---	---	5.82	---

Results-Prattville: There was no significant seed treatment effect with respect to number of KB's collected on either sampling date or on yield (Table 5). The percentage of girdled plants was significantly greater in the fungicide-only plots than in the Gaucho plots. Numbers of 3CAH were very low, ranging from 0.45 to 1.1 per 10 sweeps in the seed treatments on 8/03. There was a significant treatment effect with respect to the number of

KB's sampled on 8/17 following spray treatments on 8/04 (Table 6). There were significantly more KB's collected in the Admire Pro treatment than in the other treatments.

Table 5. Mean number of Kudzu Bugs per 10 sweeps, percent girdled plants and yields in soybeans receiving different neonicotinoid seed treatments. Prattville, AL 2016

	Number Per 10 Sweeps		Percent Girdled Plants	Yield Bu/Acre
Seed Treatment	8/03	8/17		
Fungicide only	24.5	20.1	11.1 A	39.5
Gaucho	21.8	20.9	6.5 B	37.3
Poncho	20.4	19.8		39.0
Cruiser	25.7	19.4		39.4
P>F =	0.16	0.96	0.086	0.15
LSD 0.1 =	---	---	4.3	---

Table 6. Mean number of Kudzu Bugs per 10 sweeps and yields in soybeans receiving different neonicotinoid or pyrethroid foliar sprays on August 4. Brewton, AL 2016

	Number Per 10 Sweeps		
Foliar Treatment	8/03	8/17	Bu/Acre
Untreated	24.1	18.7 B	38.1
Admire Pro 1.7 oz/acre	20.9	27.4 A	38.9
Centric 2.0 oz/acre	23.6	19.9 B	39.4
Belay 6 oz/acre	22.9	18.4 B	37.9
Brigade 6.4 oz/acre	23.9	15.6 B	39.7
P>F =	0.40	0.0053	
LSD 0.1 =	---	5.2	

Effect of Planting Date on 3-Cornered Alfalfa Hopper and Kudzu Bug Infestation Levels and Economic Loss in Alabama Soybeans

T. Reed

Materials and Methods: This study was conducted at the Prattville Agricultural Research Unit. The 4 Planting Dates and the varieties planted on each date were as follows: Planting Date (PD) 1=5/10—AG54X6; PD 2=5/23-Pioneer 95Y70; PD 3=6/14—Pioneer 95Y70; PD 4=6/29—Pioneer 47T36R. There were 4 replications of each planting date with 16 rows in each plot. Half the rows were sprayed with 6.4 oz/acre of bifenthrin on each of the following dates. (Only PD1 and PD2 were sprayed the first spray date) Spray Date (SD) 1=6/8; SD 2=7/15; SD 3=7/26; SD 4= 9/13. Plots were sampled using a 15 inch diameter sweep. Plots were sampled on 6/24, 7/8, 7/13, 7/21, 8/3 and 8/17. 10 sweep net sweeps were made in each plot each time it was sampled.

Results: Sweepnet samples taken on several sampling dates indicated relatively low numbers of 3CAH's were present during the study. The highest mean number recorded was 8 per 10 sweeps on June 7 in the PD1 plots with plants in the early V4 to V5 stage and 8.5 inches tall. The next highest recorded density was 3.5 per 10 sweeps on July 8 in sprayed PD 2 plots. The PD 1 plots also had the highest mean percentage of main stem girdles averaging 36.7% in the unsprayed plots and 32.8% in the sprayed plots. Main stem girdle percentages shown in Table 1 (Page 2) for the sprayed and unsprayed plots for the other 3 planting dates were as follows: PD 2=10.7 and 18.9, PD 3=11.4 and 9.0 and PD 4=6.7 and 17.6. Numbers of kudzu bugs collected on 7 sampling dates are shown in Table 1. Sub-economic threshold levels were present in all planting date treatments. The highest mean number of kudzu bugs collected was 80/10 sweeps in the PD2 unsprayed plots on 7/21. The relatively low insect pressure resulted in yields which were not significantly different by planting date (P>F =0.165); or spray treatment (P>F = 0.25).

Table 1. Number of kudzu bugs per 10 sweeps in sprayed and unsprayed soybean plots with different planting dates at Prattville, AL in 2016.

		Number of kudzu bugs per 10 sweeps								
Plant	Spray	Date	Date	Date	Date	Date	Date	Date	Pct	Yiel d
Date	Trt	6/24/2 017	7/8/20 17	7/13/2 017	7/21/2 017	8/3/20 17	8/17/2 017	9/2/2 017	girdles	Bu/a
PD 1	Sprayed	0.0	25.3	17.8	20.5	5.8	14.3	1.8	36.7a	33.5
PD 1	Unsprayed	0.0	23.0	25.0	66.8	15.3	15.0	7.8	32.8a	34.3
PD 2	Sprayed	0.0	10.8	27.8	12.3	5.5	11.0	4.3	10.7cd	36.3
PD 2	Unsprayed	0.0	21.5	23.8	80.0	13.0	11.8	4.3	18.9b	32.8
PD 3	Sprayed		0.0	13.5	9.0	10.5	18.5	5.3	11.4b-d	35.4
PD 3	Unsprayed		0.5	13.0	57.0	27.0	23.8	7.3	9.0d	34.2
PD 4	Sprayed	----	---	8.8	1.0	5.3	24.8	8.8	6.7d	40.0
PD 4	Unsprayed	----	---	14.8	0.5	5.0	33.0	10.5	17.6bc	36.8

Efficacy of Bt Soybean in Preventing Yield Loss to Caterpillars

T. Reed and R. Smith

Materials and Methods: A total of 10 different entries were planted on July 7, 2016 at the Gulf Coast Research and Extension Center at Fairhope. The entries were all Group 3.5 soybeans and no entry possessed a GMO herbicide-resistant trait. One entry lacked the Bt protein(s). There were 3 replications for each entry with entries arranged in a RCB design. Each plot was 4 rows wide and 30 feet long with a row spacing of 38 inches. Soybeans were grown using standard production practices. Plots were sprayed with 2 oz/acre of Centric to reduce beneficial arthropods on July 21. Plots were sampled for caterpillars by vigorously shaking plants over a 3-foot wide ground-cloth at two locations in each plot on each sampling date. Rows 1 and 4 were sampled for caterpillars. Plots were sampled 7 times on a weekly schedule from 8/16 through 9/28. Per cent defoliation was estimated on each sampling date. Rows 2 and 3 in each plot were harvested on 10/20. Yields were converted to bushels per acre at 13% moisture.

Results. Few caterpillars were found in the Bt entries and defoliation levels remained below 2% during the study for all Bt entries. Beetles and grasshoppers caused most of this defoliation. There were a few velvet bean caterpillars (VBC) and soybean loopers (SBL) found on the Bt soybeans but these likely developed on morningglories that were present in plots. SBL's were in the plots on the first sampling date and they were present in the trial each week of sampling. The plant stage of development and average number of SBL's /meter of row each sampling date in the non-Bt plots were as follows: R4.9-8/16-5.3/m; R5.2-8/25-1.9/m; R5.4-9/1-3.8/m, R5.6-9/8-3.6/m; R5.8-9/14-8.6/m; R6-9/21-3.8/m; R6.2-9/28-0.4/m. VBC's were the main defoliating caterpillar in this study. Mean number of VBC larvae and % defoliation for the non-Bt entry on each sampling date were as follows. 8/16-0/m-2%; 8/24-0.2/m-3%, 9/1-0/m-3%; 9/8-11.7/m-3%, 9/14-18.3/m-10%; 9/21-13.3/m-35%; ; 9/28-8.8/m-45%. There was no significant difference in yield among the 10 entries (P>F=0.76). Yields in these dry land soybeans ranged from 37.8 to 44.5 bu/ac for the 10 entries with the non-Bt entry yielding 38.4 bu/acre. The higher levels of defoliation occurred after soybeans neared maturity and leaf loss did not impact yield. The Intacta variety with single Bt gene resistance that is currently being planted on 30 million acres in South America was included in the trial. It is likely that commercial varieties of Bt soybeans will be available for sale in the U.S. in the near future and experiment station evaluation in Alabama provides farmers with an opportunity to gain insight into the value of this new technology.

Determining the Optimum Insecticide(s) for Controlling the Complex of Caterpillar Species Infesting Soybeans in Alabama

T. Reed and R. Smith

This study was conducted at the Brewton Ag Research Unit. Pioneer 95Y70 soybeans were planted June 3, 2016 using a 36 inch row spacing. Plots were 8 rows wide and 30 feet long. There were 10 insecticide treatments and 2 unsprayed control treatments with 4 reps/treatment arranged in a RCB design. Insecticide treatments were sprayed 8/18 using John Deere PSL DAQ 1002 nozzles 30 psi, and 20 gallons of spray per acre. Plots were sampled with a 3 foot long drop cloth on 8/23 (5DAA) and 8/31 (13 DAA). Plants were shaken vigorously on both sides of the drop cloth at 2 locations in each plot on each sampling date. Defoliation was estimated in each plot on 8/23, 8/31, 9/15 and 9/21. Plants were harvested 11/2 and yields were converted to bushels/acre at 13% moisture.

RESULTS: Numbers of soybean loopers and green cloverworms recovered in the different treatments on both sampling dates are presented in Table 1.

Table 1. Efficacy of different insecticides in controlling soybean loopers and green cloverworms in soybeans. Brewton, AL 2016

		SBL[1] Per 12 feet		GCW[2] Per 12 Feet	
Insecticide	**Rate Per Acre**	**5 DAA**	**13 DAA**	**5 DAA**	**13 DAA**
Intrepid Edge	4 oz	12.8 de	0.5 b-d	0.3 b	0.0 b
Intrepid Edge	5 oz	6.0 e	1.8 cd	0.0 b	0.0 b
Besiege	6 oz	23.5 bc	2.5 b-d	0.0 b	0.0 b
Belt	2 oz	37.0 a	1.8 cd	0.0 b	0.0 b
Prevathon	14 oz	14.8 d	1.5 d	0.0 b	0.0 b
Untreated	---	42.0 a	4.3 bc	20.3 a	4.5 a
Brigade + Intrepid	6.4 oz + 5.0 oz	28.3 b	3.0 b-d	0.0 b	0.0 b
Intrepid	5.0 oz	16.5 cd	1.5 d	1.0 b	0.0 b
Brigade	6.4 oz	41.5 a	4.8 b	0.0 b	0.0 b
Blackhawk	2.2 oz	10.25 de	1.5 d	0.5 b	0.0 b
Untreated	---	38.8 a	10.3 a	15.8 a	4.8 a
Besiege	8 oz	18.5 cd	0.8 d	0.0 b	0.0 b
	P>F =	0.000	0.003	0.000	0.000
	LSD 0.1=	8.3	2.6	5.3	1.4

[1] SBL = soybean looper larvae [2] GCW= green cloverworm larvae

All insecticide treatments except Belt and Brigade had significantly fewer SBL larvae than the untreated plots at 5DAA. Brigade + Intrepid and Besiege at 6 oz/ac had significantly more SBL larvae than Prevathon, Blackhawk and both rates of Intrepid Edge. The reduced mortality in the Brigade + Intrepid vs Intrepid alone and the Besiege (which contains chlorantraniliprole + lambda cyhalothrin) vs Prevathon (chlorantraniliprole) at 5DAA may have been due to the anti-feeding effect that pyrethroids have on soybean loopers. The 14 oz/acre rate of Prevathon contains 0.047 lbs a.i. of chlorantraniloprole which is 90% of the amount of active chlorantraniloprole in the 8 oz/acre rate of Besiege. By 13 DAA SBL numbers had declined significantly in all treatments including by 82% in the unsprayed plots. Green cloverworm mortality at 5DAA was at or near 100% in all insecticide treatments. Per cent defoliation failed to reach 10% in any insecticide-treated plot through

9/21 (31 DAA). % Defoliation in unsprayed plots averaged 10, 27, 32 and 40 per cent in unsprayed plots on 8/23, 8/31, 9/15 and 9/21, respectively. Defoliation increased from 27% to 40% in September in control plots due to a significant number of velvetbean caterpillar larvae which failed to develop in any insecticide-treated plots. Per cent defoliation did not exceed the economic threshold before the plants reached the R6 stage and there was no statistically significant treatment effect (at the 90% level of confidence) with respect to yield (P>F= 0.704). Plots yields ranged from 48.1 to 53.0 bu/acre in these irrigated plots.

State Pheromone Trapping Program for Soybean Looper, Soybean Podworm, Tobacco Budworm and Heliothis Armigera

T. Reed, A. Jacobson and R. Smith

A statewide pheromone trapping program was conducted in 2016 to assess the moth activity level for 4 species of lepidoptera which can be pests of soybeans. Species monitored were soybean looper (SL), soybean podworm (SPW), tobacco budworm (TBW) and the potentially invasive species *Heliothis armigera (HA)*. All moths collected in HA traps and many moths caught in SPW traps were tested using a DNA based technique to confirm the species present. The trapping program was conducted from the 3rd week of June through the 2nd week of September. Counties in which traps were placed are presented in the results section.

Results: Soybean Podworm (SPW) moth trap catch numbers were much higher in Baldwin, Elmore and Autauga counties than at the other 4 trapping sites. Baldwin county SPW moth numbers began increasing the 4th week of June (132) and ranged from 282 to 347/week for the next 4 weeks. SPW moth numbers at the Baldwin county site then declined the 1st week of August (136), peaked at 549 the 3rd week of Aug. then declined to 158 or less for the remainder of the year. SPW moth trap catches at the Elmore county site jumped the 1st week of July (419) and except for the 2nd week of Aug (6 caught) the SPW moth catch ranged from 200 to 612 through the 4th week of Sept. The SPW trap catch numbers in Autauga county (Prattville Research unit) peaked the 1st two weeks of Sept. The SPW moth catch at the Macon county site peaked the 1st week of Aug. at 229. The SPW trap catch in Limestone County (Belle Mina Station) began increasing the 4th week of June (78 caught) and peaked the 1st week of Aug.at 181. The only reported economic infestation of pod worms on soybeans in AL in 2016 was in a few fields in north AL in the Hillsboro area within 25 miles of the Belle Mina trapping site. These larvae were in the 6th instar stage on Aug. 6 indicating that eggs were deposited by moths about July 25 when the SPW moth trap catch at Belle Mina was 83 for the week. The Henry county trapping site at the Wiregrass Research Station caught very few SPW moths all season (total of 70). Numbers of SPW moths trapped at the Escambia county site at the Brewton Research station were also low all season and numbers ranged from 40 the 2nd week of Aug. to 2 the 3rd week of Sept.

The Tobacco budworm (TBW) moth trap catch was highest in Elmore county with the largest numbers collected the 3rd week of June (227), the 3rd week of July (236) and the 1st and 2nd weeks of Aug. (ca. 150/week). The TBW moth catch in Baldwin county reached 121 the 2nd week of July then declined for 3 weeks and rebounded to 143 the 2nd week of Aug. before declining again. The Henry county TBW moth catch was highest the 3rd week of June (58), the 1st and 2nd weeks of July (45) and the 3rd week of Aug. (42). The Limestone county TBW catches showed peaks at 38 the 1st week of July, 70 the 4th week of July and 55 the first week of Sept. The Macon county site peaked the 1st week of August at 66. The next highest sampling period was the 3rd week of Aug with 19 collected. The highest number of TBW moths were collected at the Autauga county site the 4th week of July (53), the 2nd week of Aug. (41) and the 2nd week of Sept. (67).

Soybean looper (SBL) moths were the most abundant species trapped in this project. SBL moth numbers increased first in Baldwin county rising steadily from 50 the 3rd week of June to 457 the 2nd week in July. Numbers then ranged from 316 to 604 from the 3rd week of July through the 4th week of Aug. Counts peaked the 1st week of Sept at 1102. A soybean variety trial at the Gulf Coast station was sprayed for soybean loopers on Aug. 17. A consultant reported that looper sprays in soybean fields in Baldwin county were initiated the 1st week of August. Escambia county SBL moth numbers increased steadily from 19 the 1st week in July to 680 the 2nd week of Aug. This correlated well with the presence of significant numbers of 6th instar SBL larvae in plots at the Brewton station on August 23. During the next 4 weeks SBL moths averaged 275/week at Brewton. The Elmore county SBL moth catch ranged from 56 to 85 during the 1st through 3rd weeks of July then increased to 151 the 4th week of July. Numbers then Jumped to 437 the 1st week of Aug before declining to 253 the next week. Numbers rebounded to 550 and 590 the next two weeks. The Limestone county trap catch increased from 12 the 3rd week of June to 63 the 3rd week in July. This catch then rose from 122 the last week of July to 490 the 3rd week of Aug. Numbers peaked the 3rd week of Sept. at 1501.

Heliothis armigera (HA) moths were trapped in Baldwin, Escambia and Henry counties. All moths collected in traps baited with Heliothis armigera as well as numerous moths caught in Helicoverpa zea traps were tested and no moths were found to be HA moths.

VI. Nematode Management

Root Knot Nematode Species Identification for Soybeans

K. S. Lawrence, E. Sikora, D. Delaney, P. Donald, and W. Groover

The Root-knot nematode is common in Alabama and as soybean acreage has increased this nematode has become more of a management problem. Two separate surveys indicate that more than 10% of Alabama soybean fields have a detectable level of root-knot nematodes. Successful crop rotations depend on identification of the root knot nematode species and races present in the field. In Alabama, we have the southern cotton root-knot, peanut-root knot and soybean root-knot and they are not crop specific.

Objective: Our objectives are to collect root knot nematode samples from across the state and determine the species and races present using the traditional host differential test, morphological characterization, modified isozyme analyses of root-knot nematode species, and DNA analysis.

Root-knot nematodes populations were collected from soybean fields displaying nematode problems in Alabama during the 2016 season. The populations were collected from seven locations across three counties (Covington, Butler, and Escambia). Root-knot populations were increased in the greenhouse at the Plant Science Research Center on the Auburn University campus. The traditional host-differential tests were established for each population in the greenhouse this fall semester. The nematode populations are allowed to increase on tomato, watermelon, pepper, tobacco, cotton, peanut, corn, and soybean for 45 days and populations are quantified to determine species and races present in the field. Populations were also analyzed via morphological measurements and molecular genetic identification. DNA analysis was run on individual second stage juveniles from these populations using primers specific to species found in this region.

Preliminary results: The majority of Root-knot nematode populations found so far have been determined to be Meloidogyne incognita race 3, or our southern root-knot nematode, using the host differential tests. *Meloidogyne arenaria* race 1 has also been found on multiple peanut populations. Three more tests are ongoing in the greenhouse currently.
Several molecular protocols have been tested for distinguishing the most common and economically important Root-knot nematode species. DNA was extracted from individual second-stage juvenile nematodes of the root knot populations collected and increased in the greenhouse. DNA was extracted and amplified by PCR. JB3 and JB5 primer sets have identified our Root-knot samples as Meloidogyne, and multiple specific primers have identified our Root-knot samples as Meloidogyne incognita. These species-specific primer sets are known as MI-F/MI-R, Inc-K14F/Inc-K14R, and Finc/Rinc. The primer set Far/Rar has also been used to successfully identify populations off peanut collected in south Alabama as *Meloidogyne arenaria*.

Outcome: The pathogenic Root-knot populations collected from soybean fields in Alabama to date have been identified as Meloidogyne incognita race 3 by the host plant differential test, morphological characteristics, and as *Meloidogyne incognita* with species-specific primers. *Meloidogyne arenaria* race 1 has been identified only on peanut. We are working on the isozyme and DNA analysis.

Soybean Variety Yield Comparison with and without Avicta for Management of Root-knot Nematode in Tallassee Alabama, 2016

D. Dodge, K. S. Lawrence, W. Groover, S. Till, D. Dyer, and M. Hall

Five varieties were evaluated for performance in root-knot nematode infested plots when planted with and without Avicta nematicide. The trial was planted at the Plant Breeding Unit (PBU) research station in Tallassee Alabama on 26 Apr. The soil type at PBU is Kalmia loamy sand (80% sand, 10% silt, 10% clay). The treatments in the trial consisted of varieties without Avicta and the same varieties treated with Avicta 500 FS (0.15 mg Abamectin/ seed). Plots consisted of 2 rows, 7.6 m long with 0.9 m row spacing. Treatments were arranged in a randomized complete block design with five replications. Herbicides, insecticides, and fertilizers were applied based on Alabama Cooperative Extension System standard recommendations. Plots were irrigated as needed with center pivot irrigation. Plant stands were recorded 14 days after planting (DAP). Four plant samples per plot were taken 35 DAP; plant height, shoot and root fresh weights were recorded from these samples. Nematodes were extracted from roots by 4 min agitation in a 6% NaOCl solution and captured on a 25 µm sieve for enumeration. The trial was machine harvested on 3 Oct. Data were analyzed by ANOVA with SAS 9.4 (SAS Institute); mean values were compared statistically using pairwise Tukey's procedure ($P \leq 0.10$). Monthly average maximum temperatures from planting in April through harvest in October were 24.2, 27.9, 32.7, 34.1, 33.3, 33.3, and 29.4°F with average minimum temperatures of 10, 14.16, 19, 21, 21.4, 18.2, and 10.6°C, respectively. Rainfall accumulation for each month was 20.6, 4.5, 7.2, 7.5, 10.5, 2.4, and 0.58 with a total of 53.2 cm over the entire season.

Root-knot nematode pressure in the field was high. Plant stands did not differ significantly among all treatments (data not shown). Avicta treatment did not significantly reduce nematode population density. Avicta treatment did not significantly increase yield. The root-knot resistant Mycogen variety with and without Avicta as well as the moderately root-knot-resistant Asgrow variety with and without Avicta, produced significantly greater yield than the root-knot susceptible Progeny variety without Avicta. The Mycogen variety treated with Avicta had a significantly lower nematode population density than Progeny without Avicta.

Variety	*M. incognita* Eggs/g Root		Soybean Bu/A	
Asgrow 5935 Untreated	2513	ab[y]	39	a
Asgrow 5935 Avicta	1303	b	38	a
Mycogen 5N522R2 Untreated	2183	b	40	a
Mycogen 5N522R2 Avicta	2399	ab	41	a
Progeny 5333 RY Untreated	6194	a	18	b
Progeny 5333 RY Avicta	3065	ab	24	ab
UA 5414RR Untreated	3310	ab	30	ab
UA 5414RR Avicta	3212	ab	34	ab
UniSouth Genetics 75T40 Untreated	5328	a	26	ab
UniSouth Genetics 75T40 Avicta	5473	a	31	ab

[z]Eggs per gram root calculated by dividing total number of nematode eggs divided by total weight of root system.
[y]No significant differences between columns with the same letter at $P \leq 0.10$ from Tukey's.

Soybean Variety Yield Comparison with and without Avicta for Management of Root-knot Nematode in Fairhope Alabama, 2016

D. Dodge, K. S. Lawrence, W. Groover, S. Till, D. Dyer, and M. Hall

Five varieties were evaluated for performance in a root-knot nematode infested field when planted with and without the nematicide Avicta 500 FS. The trial was planted 12 May at the Gulf Coast Research and Extension Center (GCREC) research station in Fairhope Alabama. The soil type at GCREC is Malbis sandy loam (59% sand, 31% silt, and 10% clay).Treatments were varieties without and with Avicta 500 FS (0.15 mg Abamectin/ seed). Soybean varieties included were: two root-knot susceptible (University of Arkansas and Progeny), one moderately root-knot resistant (Asgrow), one resistant (UniSouth Genetics) to soybean cyst nematode, and one resistant to root-knot (Mycogen). Plots consisted of 2 rows that were 6 m long with 0.9 m row spacing. Treatments were organized in a randomized complete block design with five replications. Herbicides, insecticides, and fertilizers were applied based on Alabama Cooperative Extension System standard recommendations. Plots were irrigated as needed with center pivot irrigation. Four plant samples per plot were taken 48 DAP; plant height, shoot and root fresh weights were recorded from these samples. Nematodes were extracted from roots by 4 min agitation in a 6% NaOCl solution and captured on a 25-µm sieve for enumeration. The trial was machine harvested on 31 Oct. Data were analyzed by ANOVA with SAS 9.4 (SAS Institute); average values were compared statistically using pairwise Tukey's procedure ($P \leq 0.10$). Monthly average maximum temperatures from planting in May through harvest in October were 28.16, 31.61, 32.2, 31.77, 31.5, and 28.5°C with average minimum temperatures of 17.72, 21.7, 23.7, 23.4, 21.5, and 12.1°C, respectively. Rainfall accumulation for each month was 5.86, 8.61, 7.39, 10, 0.0 and 0.0 with a total of 81 cm over the entire season.

Root-knot nematode pressure in the field was moderate to high. Treatments did not significantly differ in nematode population density. Yield was significantly greater for Avicta-treated Asgrow 5935 than Progeny, University of Arkansas, and Unisouth Genetics varieties with and without Avicta.

Variety	Root-knot eggs/ g of root		Soybean Bu/A	
Asgrow 5935	838	a[y]	63	ab
Asgrow 5935 Avicta	81	a	71	a
Mycogen 5N522R2	96	a	46	bc
Mycogen 5N522R2 Avicta	88	a	48	ab
Progeny 5333 RY	513	a	27	c
Progeny 5333 RY Avicta	621	a	40	c
Univ of Arkansas 5414RR	313	a	38	c
Univ of Arkansas 5414RR Avicta	45	a	32	c
UniSouth Genetics 75T40	300	a	34	c
UniSouth Genetics 75T40 Avicta	209	a	42	bc

[z]Eggs per gram root calculated using nematode eggs divided by weight of root system.
[y]No significant differences between columns with the same letter at $p \leq 0.10$ fro received m Tukey's.

Soybean Variety Yield Comparison with and without Avicta for Management of Root-knot Nematode in Brewton Alabama, 2016

D. Dodge, K. S. Lawrence, W. Groover, S. Till, D. Dyer, and M. Hall

The yield and nematode population density of five soybean varieties with and without Avicta 500 FS (abamectin 0.15mg ai/seed) were evaluated in root-knot nematode infested plots. The variety trial was planted May 9 at the Brewton Agricultural Research Unit (BARU) in Brewton Alabama. The soil type at BARU is Benndale fine sandy loam (73% sand, 20% silt, and 7% clay).Treatments were varieties without Avicta and the same varieties treated with Avicta 500 FS (0.15 mg abamectin/ seed). Plots consisted of 2 rows that were 5.5 m long with 0.9 m row spacing. Treatments were organized in a randomized complete block design with five replications. Herbicides, insecticides, and fertilizers were applied based on Alabama Cooperative Extension System standard recommendations. Plots were irrigated as needed with center pivot irrigation. Plant stand was taken 14days after planting (DAP). Four plant samples per plot were taken 38 DAP; plant height, shoot and root fresh weights were recorded from these samples. Nematodes were extracted from roots by 4 min agitation in a 6% NaOCl solution and captured on a 25 µm sieve for enumeration. Plots were machine harvested on 12 Oct. Data were analyzed by ANOVA with SAS 9.4 (SAS Institute); average values were compared statistically using pairwise Tukey's procedure ($P \leq 0.10$). Monthly average maximum temperatures from planting in May through harvest in October were 28.3, 32.5, 33.1, 32.7, 32, and 28.8°C with average minimum temperatures of 15.9, 25.7, 21.7, 22.2, 19.83, and 12.05°C, respectively. Rainfall accumulation for each month was 7.39, 7.62, 14.75, 4.08, 10.36 and 0.0 with a total of 45.9 cm over the entire season.

Root-knot nematode pressure in the field was low and highly variable. The Avicta nematicide seed treatment did not significantly increase plant stand, which ranged from 30 to 24 plants per m (data not shown). There were no significant differences in nematode population density between treatments. Yield was significantly greater for Progeny treated with Avicta than the soybean cyst nematode-resistant, untreated UniSouth Genetics variety. Low nematode population density may account for lack of significant differences in yield and nematode population density of these varieties.

Variety	*Meloidogyne incognita* eggs per gram root[z]		Soybean Bu/A	
Asgrow 5935 Untreated	321	a[y]	34	ab
Asgrow 5935 Avicta	38	a	35	ab
Mycogen 5N522R2 Untreated	1	a	35	ab
Mycogen 5N522R2 Avicta	8	a	36	ab
Progeny 5333 RY Untreated	55	a	24	ab
Progeny 5333 RY Avicta	8	a	40	a
Univer. of Arkansas 5414RR Untreated	49	a	32	ab
Univer. of Arkansas 5414RR Avicta	1	a	34	ab
UniSouth Genetics 75T40 Untreated	142	a	25	b
UniSouth Genetics 75T40 Avicta	1165	a	33	ab

[z]Eggs per gram root calculated by taking the total number of nematode eggs divided by weight of root system.
[y]No significant differences between columns with the same letter at $P \leq 0.10$ from Tukey's.

Soybean Variety Yield Comparison with and without Avicta for Management of *Rotylenchulus reniformis* in Belle Mina Alabama, 2016

D. Dodge, K. S. Lawrence, W. Groover, S. Till, D. Dyer, and M. Hall

A range of soybean varieties, including two susceptible (University of Arkansas and Progeny), one moderately resistant (Asgrow), one resistant to soybean cyst nematode (UniSouth Genetics), and one resistant to root-knot (Mycogen), were evaluated for performance when treated with and without the nematicide Avicta in a reniform nematode infested field. The variety trial was planted at Tennessee Valley Research and Extension Center (TVREC) at Belle Mina Alabama on 5 May. The soil type at TVREC is Decatur silt loam (24% sand, 49% silt, 11% clay, and 1% organic matter). Treatments consisted of untreated varieties and varieties treated with Avicta 500 FS (0.15 mg Abamectin/ seed). Plots consisted of 2 rows, 7.62 m long with 0.9 m row spacing, and were arranged in a randomized complete block design with five replications. Herbicides, insecticides, and fertilizers were applied based on Alabama Cooperative Extension System standard recommendations. Plots were irrigated as needed with center pivot irrigation. Four plant samples per plot were taken 34 days after planting (DAP). Plant height, shoot and root fresh weights were recorded. Nematodes were extracted from roots by 4 min agitation in a 6% NaOCl solution and captured on a 25µm sieve for enumeration. The trial was machine harvested on 7 Oct. Data were analyzed by ANOVA with SAS 9.4 (SAS Institute); mean values were compared statistically using pairwise Tukey's procedure ($P \leq 0.10$). Monthly average maximum temperatures from planting in May through harvest in October were 27.2, 33.7, 34.4, 33.2, 33.6, and 28.7 °C with average minimum temperatures of 14.9, 20.3, 22.4, 22.2, 18.5, and 12.1°C, respectively. Rainfall accumulation for each month was 3.45, 4.0, 6.9, 12.7, 0.30, and 1.1 with a total of 28.6 cm over the entire season.

Plant height and biomass did not differ significantly among all treatments (data not shown). The root knot nematode-resistant variety (Mycogen) with Avicta had a significantly lower reniform population density than all treatments except for UniSouth Genetics treated with Avicta. The yield of the Mycogen variety with or without Avicta was significantly greater than all other varieties with and without Avicta. The performance of the Avicta-treated root-knot nematode-resistant variety may direct actions of soybean growers with reniform nematode infestations.

Variety	Reniform Nematode Eggs/g root[z]		Soybean Bu/A	
Asgrow 5935 Untreated	1021	ab	27	bcd
Asgrow 5935 Avicta	493	abc	26.3	bcd
Mycogen 5N522R2 Untreated	212	bcd	35.5	a
Mycogen 5N522R2 Avicta	87	d	38.5	a
Progeny 5333 RY Untreated	993	ab	19	de
Progeny 5333 RY Avicta	649	ab	27.5	bcd
Univ of Arkansas 5414RR Untreated	1536	a	18.5	de
Univ of Arkansas 5414RR Avicta	529	ab	16.5	e
UniSouth Genetics 75T40 Untreated	193	bcd	26.2	cd
UniSouth Genetics 75T40 Avicta	106	cd	32.6	cd

[z]Eggs per gram root calculated using nematode eggs divided by weight of root system.
[y]Significant differences between rows(untreated vs treated) with asterisks, at $p \leq 0.10$ from Tukey's.

Soybean Variety Trials with Nematicides to Boost Yield Potential

K. S. Lawrence, E. Sikora, D. Delaney, and D. Dyer

Objective: To determine the yield potential of soybeans planted in nematode infested field and the benefit on the new nematicides.

Materials and Methods:

Field trial: Five commercial soybean varieties were evaluated with and without the seed treatment nematicide Avicta for their performance in reniform and root-knot nematode infested fields. The soybean varieties were planted in a reniform infested field and in a clean field without reniform at the TVREC. The varieties were also planted in an identical manner in a root-knot nematode infested field and in a clean field without root-knot at the PBU and GCREC. Nematode samples were collected near 30 days after planting by digging up four plants and extracting the reniform eggs from the roots. Plots were mechanically harvested.

Results:

TVREC field trial: Reniform nematode egg counts per gram of root were 49 % lower in the Avicta nematicide treated varieties compared to the same varieties without a nematicide. The presence of the seed treatment nematicide Avicta significantly reduced reniform reproduction on UA5414RR reducing reniform nematode eggs by 65%., although, the reniform population densities were still higher than those supported by the resistant varieties Mycogen 5N522R2 and USG 75T40. Soybean variety trials in the reniform infested field averaged 26.5 bu/A. The addition of Avicta did not increase significantly yield in 2016. Soybean yields in the clean field without reniform averaged 40 bu/A thus the reniform nematode reduced soybean yields by 13.5 bu/A or 33 % in 2016.

Table 1. Soybean varieties reniform population densities and yields when grown in fields with and without reniform and with and without nematicides, TVREC 2016.							
		Reniform eggs/gm root			Yield bu/a		
		Reniform No Avicta	Reniform Avicta	No Reniform	Reniform No Avicta	Reniform Avicta	No Reniform
1	Mycogen5N522R2*	212 bcd	87 cd	0	35 b-e	38 abc	49 a
2	USG 75T40*	193 bcd	106 cd	0	26 e-h	32 abc	39 abc
3	Asgrow 5935	1021 ab	493 bcd	0	27 e-h	26 bc	29 c-f
4	Progeny 5333RY	993 ab	650 a-d	0	19 f-h	27 ab	44 ab
5	UA 5414RR	1536 a	529 bcd	0	18 gh	16 h	38 abc
Average		**791**	**373**	**0**	**25**	**27.8**	**39.8**
Means followed by same letter do not significantly differ according to Tukeys test (P ≤ 0.1) * Indicates root-knot nematode resistant varieties. ** Indicates root-knot susceptible varieties.							

PBU field trial: Root-knot nematode egg counts per gram of root were 21% less in the Avicta nematicide treated soybean varieties than the same varieties without Avicta. The nematicide treatment did not significantly decrease nematode populations when compared to the same varieties without the nematicide in 2016. Treatment with the Avicta nematicide did not significantly increase yield in 2016. Yield of soybean varieties in the root-knot clean field were 7.9 bu/A or 20% higher than the yields of the same soybean varieties without Avicta in the root-knot infested field.

Table 2. Soybean varieties root-knot population densities and yields when grown with and without nematicides, PBU 2016.							
		Root-knot eggs/gm root			Yield bu/a		
		Root-knot No Avicta	Root-knot Avicta	No Root-knot	Root-knot No Avicta	Root-knot Avicta	No Root-knot
1	Mycogen5N522R2*	2183 bc	2400 abc	0	40 ab	41 ab	34 ab
2	USG 75T40*	5328 ab	5473 ab	0	26 ab	31 ab	33 ab
3	Asgrow 5935	2513 abc	1303 c	0	39 ab	38 ab	47 a
4	Progeny 5333RY	6194 a	3065 abc	0	18 b	24 ab	37 ab
5	UA 5414RR	3310 abc	3212 abc	0	30 ab	34 ab	43 a
Average		**3905**	**3091**		**30.8**	**33.5**	**38.7**
Means followed by same letter do not significantly differ according to Tukeys test (P ≤ 0.1) * Indicates root-knot nematode resistant varieties. ** Indicates root-knot susceptible varieties.							

GCREC field Trial: The Avicta nematicide did not significantly reduce root-knot nematode eggs per gram of root in 2016, however, Avicta treated varieties had 51% lower eggs per gram of root than the varieties without the nematicide seed treatment. The yields of soybean varieties planted in the root-knot clean field were 4.2 bu/A or 8% higher than that of the soybean varieties without Avicta planted in the root-knot infested field. The soybean varieties treated with Avicta were 5 bu/A or 11% higher in yield than the same varieties without Avicta in the infested field.

Table 3. Soybean varieties root-knot population densities and yields when grown in fields with and without root-knot and with and without Avicta neamticide, GCREC 2016.							
		Reniform eggs/gm root			Yield bu/a		
		Root-knot No Avicta	Root-knot Avicta	No Root-knot	Root-knot No Avicta	Root-knot Avicta	No Root-knot
1	Mycogen5N522R2*	96 a	88 a	0	46 abcd	48 abcd	45 bcd
2	USG 75T40*	300 a	209 a	0	34 d	42 cd	41 cd
3	Asgrow 5935	838 a	81 a	0	63 abc	71 ab	72 a
4	Progeny 5333RY	513 a	621 a	0	27 d	40 cd	31 d
5	UA 5414RR	313 a	45 a	0	38 cd	32 d	33 d
Average		**412**	**209**	**0**	**41.8**	**46.7**	**45**
Means followed by same letter do not significantly differ according to Tukeys test ($P \leq 0.1$) * Indicates root-knot nematode resistant varieties. ** Indicates root-knot susceptible varieties.							

Outcome: The reniform and root-knot nematodes reduced soybean yields by 33%, 20%, and 8% respectively in 2016. The seed treatment nematicide Avicta reduced both reniform and root-knot nematode populations. Soybean yield overall was increased by the addition of the nematicide in 2016.

VII. Extras

Maintenance and Expansion of the ACES/Auburn Univ. Web Site for Alabama Crops, 2016

T. Cutts, D. Monks, D. Delaney, and C. Dillard

The www.alabamacrops.com website was developed to serve as a central site for research and extension information on Alabama field crops. The effort has been successful for delivering several types of information including IPM guides, research updates and reports, and extension information. The site has been especially useful for rapid delivery of crop variety and pest control information. Single-year variety yield data sets are often analyzed and posted 3 weeks before publication of the full Official Variety Report, providing current information to producers, county agents, crop advisors, and industry representatives on how well specific entries performed across the state. IPM Guides were also available on-line weeks before paper publication.

The Alabama Crops site also serves as the hub for crops-related sites in areas such as Soil Testing, Newsletters, on-farm research trial reports, and on-farm variety trials. Our Web Manager Mr. Jon Brasher develops and manages the www.alabamacrops.com site and assists in the development and maintenance of the Alabama Official Variety Testing web site. The web site includes links to information on, but not limited to: cotton, corn, soybeans, forages, wheat, small grains, stored grains, IPM guides, OVT research information, on-farm research and development, hay and pasture weed control, enterprise budgets, precision ag, soil fertility, plant diagnostics and soil testing. A Crops Calendar keeps users informed of training opportunities, conferences, and meetings. Twitter and Facebook feeds notify participants when new information is posted.

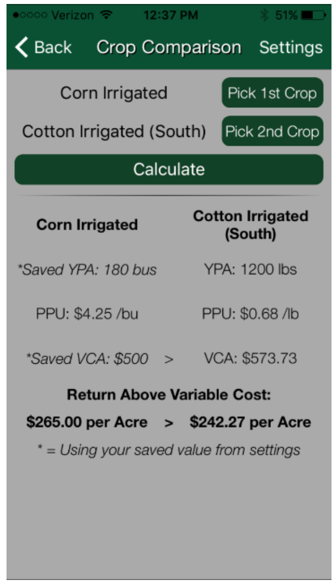
Jon's assistance to the Agronomic Crops team has been expanded to planting and harvesting on-farm tests, equipment maintenance and management, and a variety of other team activities. Jon has been trained to analyze, tabulate, and prepare research and demonstration results for posting to the web site.

Funding for this project was secured from the Alabama Cotton Commission, Alabama Soybean Producers, and Alabama Wheat and Feed Grains Committee for 2016 and will be requested for 2017. Common feedback has been that this website has been a major improvement in how we deliver our row crop information through the web.

Web statistics for the period of January 1st through December 31st indicate that the Alabama Crops web site had 15,895 visits and 22,659 page views in 2016. A **visit** is a series of actions that begins when a visitor views their first page from the server, and ends when the visitor leaves the site or remains idle beyond the idle-time limit. **Views** are hits to any file classified as a page. The analytical software used to evaluate web traffic was changed after 2015, and different metrics were used. Therefore, numbers from 2016 are not comparable to previous years. After the home page, the pages for the Alabama Variety Testing Program and Alabama Corn Production were the most visited.

Alabama Crop Production Mobile App Upgrade

T. Cutts, B. Dillard, and M. Runge



Original Features:
Original features on the Alabama Crops app include sections for: Crop Production News, Profit Profiles, Contact a Crop Specialist, Calendar, Submit a Photo/Question, and AlabamaCrops.com link.
To date, the app has been downloaded over 400 times and has been advertised at many grower events throughout the state.

Recently Added:
A crop comparison tool was recently added to allow growers to compare 2 potential crops for planting on farm. Producers can use the data from ACES budgets or each user can customize their own numbers such as yield and inputs to compare variable input costs and potential profit from two crops.

Things to come:
We are working with the app developer to give the Agronomics Team the ability to set up push notifications at planned intervals for upcoming events to make farmers aware of meetings and remind them as meeting time approaches without actively having to check the Alabama Crops App calendar.

IPM section that will allow farmers to access IPM guides with drop down menus. With drop down menus, growers could select the crop, then either disease, weed control, or insect control. This would bring up the ipm guide and section for that particular crop/issue. For example, a grower wanting herbicide options for wheat production could easily access the ipm section for chemical weed control in whe

Improving Soil Quality in Alabama

G. Huluka and C. C. Mitchell

The objective of this project was to support Alabama producers who wish to have their soils tested using the new **Alabama Soil Quality Test** through the A.U. Soil Testing Lab.

JUSTIFICATION:

Bama sandy loam, the State Soil of Alabama

Alabama Soybean Committee supported the research that led to the development of the Alabama Soil Quality Test and the Soil Quality Index (SQI) that is included in the new report. The A.U. Soil Testing Laboratory is the first and only public-supported laboratory that offers this type of service in the South. It was announced in November, 2015. One of the objectives of the effort that led to its development was to keep the cost as low as possible. Auburn University requires that all "service centers" including the Soil Testing Lab generate funds to cover their expenses. The new, comprehensive Alabama Soil Quality Test will cost $50 per sample which is half of what the Cornell University Soil Quality Test costs. Many Alabama producers and consultants who are used to paying $7 for a routine soil test may not submit soil quality samples at $50 each in spite of the fact that the Soil Quality Test includes:

Routine Soil Test
Micronutrients and heavy metals (soil contamination)
Soil CEC and Base Saturation
Soil Organic Matter
Aggregate stability/slaking test
Soil respiration (biological)
Potential N mineralization
SQI interpretation and recommendations

Report 2016

We have made significant efforts to publicize the availability of the Alabama soil quality test at Auburn University through extension county agents, Master Gardeners' class and through published media. It was also dominantly displayed on the AU Soil, Forage and Water Testing website (http://www.aces.edu/anr/soillab/soilquality.php). Currently, less than 100 samples were submitted to our lab. This is much less than we expected and we will continue encouraging our producers to take advantage of the discounted price of the test and benefit from knowing the health of their soils. An example of a report for Alabama soil quality index is presented blow. The customer will receive the SQI report, routine soil test report and mineral analysis that includes micro elements.

An Example of Alabama Soil Quality Index (SQI) Report

Alabama Soil Quality Index

Name: John Doe
Date of Report: 12/01/16
Address: AL St
County: AL County
Sample no. 2063
Sample name: LRMT 306 0-6
Previous crop: Corn
Tillage:

Factor	**Values**					**Max. value**	**Your Score**	**Recommendations**
	<4.6 (Grp 1)	4.7-9.0 (Grp 2)	9.0- 15.0 (Grp.3)	>15,0 (Grp 4)				
	2	4	5	5		5	2	
	<5.0	5.0-5.8	5.9-7.0	7.1--8.0	>8.0			
	0	10	15	10	5	15	15	
	VL/LOW	MEDIUM	HIGH	VER Y HIG H	EXTREMEL Y HIGH			
	0	5	10	5	0	10	10	
	VL/LOW	MEDIUM	HIGH	VER Y HIG H	EXTREMEL Y HIGH			
	0	5	10	8	5	10	10	
	<10%	11-25%	26-50%	50-75%	>75%			
	0	3	6	10	8	10	10	
	<1.0	1.0-2.0	2.1-3.0	3.1-4.0	>4.0			
	0	5	10	15	20	20	5	
	<10	11-20	21-30	31-50	>50			
	0	2	4	8	10	10	2	
	Very Low	Low	Moderate	High	Very High			
	0	2	4	8	10	10	2	
	No aggregates	Weak	Moderate	Strong	Very strong aggregates			
	0	2	4	8	10	10	2	
	Two or more metals "very high"		One metal is "very high"		All metals optimum			
	-10		-5		0	0	0	
TOTAL SOIL QUALITY INDEX						100	58	
COMMENTS: Moderate soil quality, continue current practices but consider implementing more BMPs. Soil could use improvement. Consider implementing one or more of the above practices.								See BMPs above.

Primary Practices (PP)

PP1. Conservation crop rotation (328)
http://efotg.sc.egov.usda.gov/references/public/AL/tg328.pdf

PP2, Residue and Tillage Management "No-till/strip till" (329)
http://efotg.sc.egov.usda.gov/references/public/AL/tg329.pdf

PP3. Cover crops (340) http://efotg.sc.egov.usda.gov/references/public/AL/tg340.pdf

PP4. Nutrient management (590)
http://efotg.sc.egov.usda.gov/references/public/AL/tg590.pdf

PP5. Integrated Pest Management (595)
http://efotg.sc.egov.usda.gov/references/public/AL/tg595.pdf

Supporting Practices (SP)

SP1. Contour Farming (330) http://efotg.sc.egov.usda.gov/references/public/AL/tg330.pdf

SP2. Deep Tillage (324) http://efotg.sc.egov.usda.gov/references/public/AL/tg324.pdf

SP3. Forage and Biomass Planting (512) – for sod based rations
http://efotg.sc.egov.usda.gov/references/public/AL/tg512.pdf

SP4. Irrigation water Management (449)
http://efotg.sc.egov.usda.gov/references/public/AL/tg449.pdf

SP5. Contour Buffer Strips (332) http://efotg.sc.egov.usda.gov/references/public/AL/tg332.pdf

SP6. Filter Strips (393) http://efotg.sc.egov.usda.gov/references/public/AL/tg393.pdf

SP7. Mulching (345) http://efotg.sc.egov.usda.gov/references/public/AL/tg484.pdf

SP8. Terrace (600) http://efotg.sc.egov.usda.gov/references/public/AL/tg600.pdf

Complete list of conservation practices can be found at:
http://efotg.sc.egov.usda.gov/toc.aspx?CatID=321

PROPOSAL 2017

Subsidize 50% of the cost of the first 500 samples submitted in order to encourage producers to submit samples. Samples will, of course, have to be limited to 5 per producer as an introductory offer. This offer will remain in effect until 500 samples have been run by the lab.

A statement on each report will be, *"This Soil Quality Test has been run at a 50% discount because of checkoff support from* Alabama Soybean Committee.*"* Other sources of funding are being solicited. If more than one source is obtained, then the discount will apply to additional samples.

System Biology of Plant-growth Promoting Rhizobacteria (PGPR) Induced Drought Tolerance in Soybean

S. W. Park and E. Sikora

OBJECTIVE: The focus of our laboratories is to develop new soybean line(s) which confers drought tolerance and growth promotion. Towards that, the proposed studies aim to generate novel genetic repertoire and candidates for the later generation of GM soybean.

SIGNIFICANCE: Our preliminary study unveiled that that cohabitation of soil borne PGPR (i.e., *Paenibacillus polymyxa* CR1, Ppc1) enables induced (**prime**) drought tolerance (Fig. 1), and concurrently growth promotion (data not shown) in soybean. In other word, Ppc1-treatment enables soybean plants to induce genes and metabolites which promote a state of heightened tolerance/resistance against drought stresses, even before the actual state of drought. At the same time, Ppc1 also are able to promote plant growth and development.

For the past decades, a number of studies have searched and, in fact, reported several genes, involved in drought avoidance or tolerance. However, most if not all of these genes turned out to be not suitable for the development of drought tolerance crops, because these are drought responsive genes, **a**) induced after plants recognize water deficiency, and **b**) render one way or the other stomatal closure. Hence, controlling level expression of these genes results in growth retardation and delay. Thus, the identification of gene(s) that is capable of priming drought tolerance without, if not enhance, compromising growth will provide new genetic and biotechnological resources to solve one of the most eminent and immediate environmental challenges in the world, drought and global warming.

RESULTS: To discern genes whose expression patterns are linked with 'drought priming', system biology approach will be employed, and reconstitute the global landscapes of dynamic gene expression changes that occur across multiple levels in the Ppc1-responsive network. Towards this end, we will initially perform **a**) time-course high resolution qRT-PCR analyses using a set of four Ppc1-induced genes (hevein-like protein, vegetative storage protein, RAS-related protein 18, and low temperature Induced protein 78; MPMI 12:951). These results then will allow us to determine when to extract Mrna (conditional gene expressions) for **b**) the subsequent, global gene expression analysis (i.e., affymetrix genechip,
http://www.affymet rix.com/ estore/).

Ppc1 induces the expression levels of *LTI78, HEL, VSP1*, and *RAB18* at as early as 6 h-post inoculation (hpi). As an initial gene expression analysis, we employed semi-quantitative (semi-q)RT-PCR, and resolved Ppc1-depednent temporal changes in the transcript levels of four Ppc1-induced (marker) genes from mRNA, prepared every 6 hpi after the 1st inoculation at 9 am in the morning, and the 2nd inoculation at 48 hpi (Fig. 2). From these data, we concluded that the 1st Ppc1-inoculation **a**) induces rapid (<6 hpi), and perhaps global, rearrangement in transcriptome, and **b**) leads second and third phase upregulations (e.g., 18 and 36 hpi in *VSP1*, or 24 and 30 hpi for *RAB18*). On the other hand, **c**) the 2nd Ppc1-treatment conveys lesser impact on than the 1st Ppc1-treatment the induction of *VSP1* and *RAB18*, although the upregulation of *VSP1* was still observed at again 6 hp-2nd inoculation.

Expression of *LTI789* and *HEL* is under control of the circadian clock regulatory mode. Our semiqRT PCR analyses (Fig. 2) found that basal (-) levels of *LTI78* and *HEL* expression are rhythmically expressed during a 24-h period. We thus examined if the circadian clock controls the expression of *HEL* and *LTI78* using high resolution qRTPCR analyses (Fig. 3). While plants were entrained under 12-h light/12- dark diurnal conditions, *LTI78* expression was peaked at early afternoon (3 pm; zeitgeber time [ZT] 8), and *HEL* expression was highest at night (11 pm; ZT16), suggesting that **a**) *LTI78* and *HEL* expressions are regulated by light or diurnal signaling, **b**) cross network between circadian clock regulatory and drought priming modes, for instance Ppc1-induction of *LTI78* at 18, 42, 66 and 90 hpi could be more meaningful that that at 6, 30, 54 and 78 hpi (Fig. 2).

Ppc1-indueced transcriptional rearrangement is inter-connected with the circadian clock regulatory gene expressions.

We next investigated whether the rhythmic pattern of *HEL* and *LTI78* expressions persisted after Ppc1 inoculation. Indeed, the levels of *HEL* and *LTI78* expressions induced upon Ppc1 inoculations constantly presented oscillatory patterns (Fig. 4, next page), indicating that interplay between the circadian- clock and Ppc1 regulations underlines the mode of action of drought priming. Further studies are needed to better understand the intertwined regulatory mechanisms of plants, and their redundant and specific metabolic pathways by (or towards) multiple environmental cues such as drought, circadian clock, light and microbes; these will be critical to, in pursuit of developing a new cultivar conveying drought tolerance and growth enhancement, fine tune energy fitness between growth and stress defense, precisely allocating resource towards two different physiological states to sustainably increase crops yields and productions.

Ppc1 induces *PR1* expression. Our preliminary study exhibited that Ppc1 is capable of stimulating the level expression of *PR1* (*PATHOGNESIS RELATED PROTEIN 1*) transcript (Fig. 5). Thus far, a large number of most, if not all, studies have suggested that the roles of PGPR is related with jasmonate and ethylene signaling pathway, and implied independent mode from salicylic acid (SA) signaling pathway. However, our results with Ppc1-ineduced *PR1* which is a key and evident marker gene of SA signaling could throw a new light on the role of PGPR, relaying its roles in SA signaling and subsequently enhanced disease resistance against biotrophic pathogens such as other pathogenic bacteria and viruses.

FUTURE DIRECTION: Together, the plant growth and RNA preparation conditions were determined. Most importantly, our preliminary results defined four experimental time points for subsequent, global gene expression analysis (0, 6, 18 and 24 hpi).

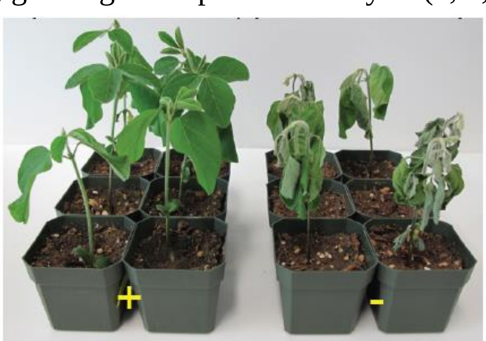


Fig 1. Application of Ppc1 enhances drought tolerance in soybean. Soybean were treated (+) with Ppc1 (10^8 colony-forming unit per mL) twice **p**ost seed **g**ermination (pg; e.i., 1 and 7 d-pg). Each pot was watered (15 mL) every other day for 2 wk-pg, and the photograph was taken 3 wk-pg.

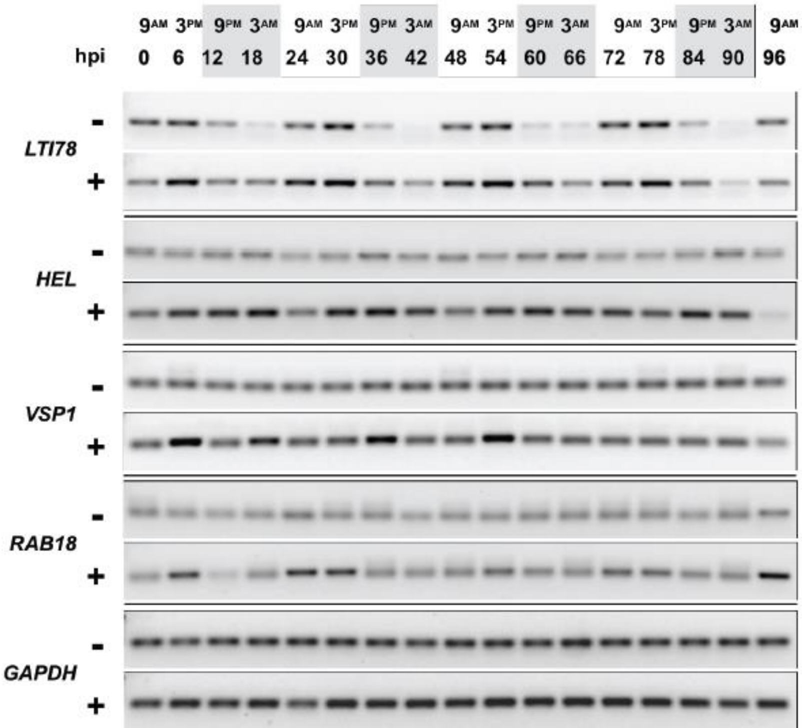


Fig 2. Time resolved semi-qRT PCR analyses of *LTI789, HEL, VSP1* and *RAB18* upon Ppc1 inoculation. Total RNA (+) was prepared from leaves at every 6 hp-1st Ppc1 inoculation at 9 am in the morning. The 2nd batch of Ppc1 was inoculated at 48 hpi. The control RNA (-) was prepared with buffer treatment. Transcript levels of *GAPDH* were used as an equal loading control. Plants were grown under diurnal conditions (12h-light/12-h dark) for 4 wk.

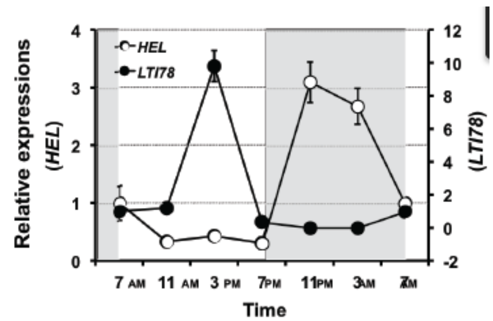


Fig 3. *HEL* and *LTI78* transcripts are both regulated by the circadian clock. qRT-PCR of *HEL* and *LTI78* to *GAPDH* control under diurnal conditions (12h-light/12-h dark).

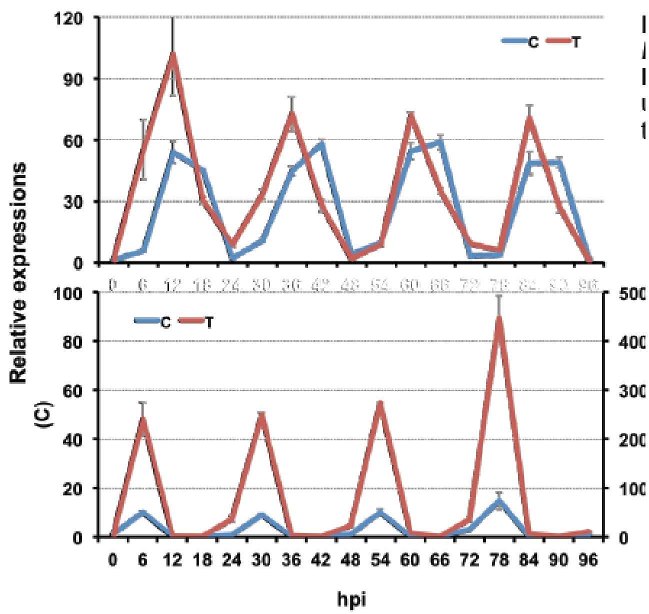


Fig 4. Time resolved high resolution qRT PCR analyses of *HEL* (upper panel) and *LTI789* (lower panel) upon Ppc1 inoculation. qRT-PCR of *HEL* and *LTI78* to *GAPDH* control under diurnal conditions (12h-light/12-h dark). C: control, and T: Ppc1 treated.

Fig 5. Time resolved semi-qRT PCR analyses of *PR1* upon Ppc1 inoculation. The red arrow indicates the size of *PR1*. Please see the Figure 2 legends for the experimental conditions.