44-2023: Improving agronomic efficiency for Mississippi soybean producers
Final Report
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Background and Objectives

Planting speed. The benefits of using precision planters have been more widely documented in corn systems than in soybean systems. Although soybean is more plastic than corn, the use of precision planting technology in soybean systems is expected to show ROI with faster planting speeds, reduced labor costs, and perhaps reduced seeding rates. During the planting season, producers face pressure to get as much land planted as quickly as possible during tight calendar and weather windows. New metering and seed delivery technology claims to enable planting at faster speeds without sacrificing singulation or stand establishment (Kinze Manufacturing, 2020). Optimal planting speed with mechanical planters is generally around 5-6 mph, but during Year 1 of this project, we were able to demonstrate adequate stands without any yield loss after planting at speeds up to 9.5 mph.

If producers can increase planting speed without sacrificing stand or yield, this should result in fewer labor hours and more time to manage early-season fertility and weed control, as well as reduce the risk of getting caught by untimely rainfall during the planting season.

Seeding rate. This aspect of the proposal was changed for a soybean seeding rate by date trial. Since the seed metering and delivery system was able to reduce spacing variability and cause no yield hit at 130,000 seed/ac which is an acceptable seeding rate in MS. We envisage that reducing seeding rate might not result in any significant change in planting spacing uniformity.

Seeding rate by date. The early soybean production system (ESPS) is now considered the norm for optimal yield in Mississippi. The ESPS combines early planting (late March through April) and early maturing indeterminate varieties (Maturity Group IV and V). The system has helped improve yield and reduced the risk of reproductive stage heat and drought stress, insect pest infestations, and weed competition. However, the ESPS planting is typically delayed by late corn planting, soil temperature, and the need to wait for fields to dry, especially those that are predominately clay in MS. Planting into cold and wet soil can delay emergence, increase imbibitional injury, reduce plant stands, seedling health, and yield. This potentially limits the benefit of early planting. Currently, Mississippi State recommends a seeding rate of 100,000 to 140,000 seeds/acre. The recommended seeding rates aim to ensure that the harvest population does not result in a yield hit regardless of environmental conditions. However, like the planting date, soybean seeding rate is also expected to impact the pattern of plant growth and development and increase production costs due to the ever-increasing seed cost. Hence, the need to understand the effect of seeding rate and planting date on soybean production in MS.

Fertility
Fall-applied fertilizer is likely to reduce nutrient use efficiency, resulting in greater fertilizer expense to soybean farmers compared to spring applications. The trials determined if P, K, and S fertilizer rates can be reduced when spring-applied compared to fall-applied as well as refine rate recommendations. These trials provide an excellent opportunity to determine if soil test lab recommendations are keeping pace with modern soybean production goals in Mississippi. To that end, is used these trials to begin collecting data to determine if statewide soil test correlation and calibration data, as well as the resulting recommendations they produce, require updating for soybean P, K, and S response. We utilized both Mehlich 3 and Lancaster extractants in order to compare the most common soil test procedures and refine correlation and calibration data used to make fertilizer recommendations.

Cover Crop Management
Barriers to management of cover crops include establishment in furrow irrigated (bedded) systems and interference of cover crop residue during soybean planting. Prior to launching detailed investigations into the response of soybean due to cover crops, we have opted for the strategy to first determine optimal methods of cover crop establishment before looking at other cover crop management practices, such as mixes, termination, timing, and plant and soil responses to those practices. We reason that we must develop good methods to establish cover crops in bedded systems before we can begin further work on those systems. The main question of interest is how soybean respond to different cover crop establishment practices. Cover crops may be spatially arranged in bedded systems to either increase or decrease the amount of residue that remains on the bed, which could affect soybean planting the following spring. We propose to broadcast cover crop seed before or after fall bedding to see if the resulting spatial arrangement of residue can facilitate subsequent soybean planting and establishment. We further developed a prototype soybean combine seeder which can be mounted behind the soybean combine header to drop cover crop seed during harvest. The advantage of this is that cover crop seed would then be covered by crop residue, facilitating planting and establishment of cover crops without the need for an additional pass to plant the cover crop. This system for cover crop establishment is currently being tested.

Objectives
<u>Objective 1:</u> To quantify soybean response to precision planting technologies.
<u>Objective 2:</u> To increase fertilizer use efficiency.
<u>Objective 3:</u> Develop strategies to improve cover crop performance and management in soybean systems.

Report of Progress/Activity
Objective 1:
Planting speed
Trials were planted at three MS locations: two Mississippi State University research stations at Brooksville and Stoneville and one on-farm in Marks. A Case Maxxum 125 tractor with 125 horsepower was used to operate two 8-rows unit planters. The two planter types were a mechanical planter (JD MaxEmerge XPTM) and a precision planter (equipped with Ag Leader® SureSpeed with SureForce). Actual speeds were 6 mph for the mechanical planter and 6, 9, and 11 mph for the precision planter at the two research stations in Stoneville and Brooksville. For the on-farm trial, the precision planter was only tested at two actual speeds (6 and 10 mph). The experiment

was a randomized complete block design with 4 replications at all locations, including the on-farm location, with the mechanical planter serving as a check. Plots were 25.3 × ≥140 ft long. Soybean variety 4795XS was planted at 140,000 seeds/ac. Plots were planted as a 'strip trial,' i.e., a single planter pass for each treatment. Data were collected on plant stand and spacing. Plant spacing variability was estimated. Yield was also estimated at harvest using a newly procured weigh wagon.

Results indicate no differences in yield (all locations) and plant stand variability (Stoneville and on-farm) (Table 1). Plant stand/ac were statistically different at all locations. The observed difference in plant stand/ac and stand variability (in Brooksville) can be attributed to the difference between the performance of the precision planter and the mechanical planter check. Regardless of planting speed, no statistical differences were observed in soybean plant stand, spacing distribution, and yield when using the precision planter (Figure 1 - Figure 3). However, increased planting speed numerically increased in-row spacing variability and lowered plant populations. When operating at the highest attained planting speed (11 mph), the precision planter exhibited the same level of performance as the traditional mechanical planter running at the lowest speed (6 mph) (Figure 1 - Figure 3). This suggests that an increased planting speed can be achieved without detrimentally affecting plant population, plant spacing, or yield in soybean production. Hence, MS soybean producers can plant more acreage within the critical planting window and increase yield as a result.

Planter technology return on investment (ROI)

Planter technology return on investment (ROI) was analyzed by comparing the net returns (revenue minus total costs) of a mechanical planter to a precision planter without downforce, based on average days suitable for fieldwork from 2019-2023 in Mississippi (USDA NASS, 2024). Basic assumptions include:

- 12-row planters (mechanical and precision planters)
- 38-inch row spacing
- 2,000-acre soybean farm
- \$12.00/bu soybean price
- Mechanical planter @ 5 mph and precision planter @ 9 mph.

Using the standard machine cost calculation formula, the mechanical planter will plant 2,000 acres in 133.6 hours (15 acres per hour) while the precision planter will plant the same acreage in 74.2 hours (26.9 acres per hour). This means that a precision planter would reduce planting days from start to finish from 23 days to 13 days based on the USDA NASS average days suitable for fieldwork from 2019-2023 (Table 2). At \$12.00/bu soybean price, the precision planter will increase revenue by \$28,140.25 per 2,000-acre field. Total costs decreased by \$6,767.51 per 2,000-acre field, leading to an increase in net returns of \$34,907.76 per 2,000-acre field.

Seeding rate by date

This trial was conducted in Starkville only due to challenges with equipment setup (wiring harness issues). Regrettably, as can happen with research on new technology, the trial had to be planted with a mechanical planter instead of the precision planter in the interest of hitting target planting dates. As compensation and to make the experiment more interesting and useful, we included another factor, planting date, to investigate optimal seeding rate x planting date interactions. The experimental design was a randomized complete block in a split-plot arrangement with four reps. Main plots were four target planting dates (April 1, April 21, May 14, and June 7), and subplots were four seeding rates (50,000, 80,000, 110,000, and 140,000 seeds/ac). The actual planting dates were April 1, April 17, May 15, and June 8. Data were collected on growth stages. Yield was determined by harvesting the center two rows of each plot with a plot combine and adjusted to 13% moisture content. Three other yield components (number of branches per plant, number of pods per plant, and seed mass per plant) were recorded from five random plants in border rows. Analysis of variance (ANOVA) was computed for all measured traits using the PROC GLIMMIX in SAS. Means were separated at an alpha value of 0.05 LSD.

Planting date significantly influences the measured intervals (days) between soybean growth stages (Table 2). Effects of seeding rate (except R6 to R8) and planting date × seeding rate interaction were not significant for all intervals. Mean intervals between soybean growth stages by planting date are presented in Table 3. For the post-harvest data, the planting date significantly influenced all measured traits except seed mass per plant (Table 4). Similarly, the effect of seeding rate significantly influenced yield components but not yield. However, the seeding rate and planting date interaction was not significant for all measured traits. Yield components decreased with the delay in planting date except the number of pods per plant, where the May 14th planting date had 14 more pods/plant than the April 1st planting date. Yield was lowest with the earlier planting dates (1st and 21st April) and highest on the later planting dates (14th May and 7th June), but this result can be attributed to deer browsing on the early planting dates. Yield components decreased with increased seeding rate. Yield was highest at eighty thousand seed/ac. In conclusion, results should be interpreted with caution because the early planting date were affected by deer browsing.

Objective 2:
The trials were conducted at three sites: Starkville, Stoneville, and Brooksville. Soils were identified to be deficient in each nutrient before experiment initiation. Three trials were implemented, one for each nutrient: P2O5 was applied as triple super phosphate at 0, 30, 60, 90, and 120 lbs/ac, K2O was applied as potash at 0, 60, 120, 180, and 240 lbs/ac, and S was applied as elemental sulfur at 0, 10, 20, 30, and 40 lbs/ac. Both fall- and spring-applied fertilizer treatments were broadcast, followed by hipping to incorporate the fertilizer. The trials were laid out in a randomized complete block design with four replications. Plot size was 3.17 × ≥35 ft long. Leaf samples were collected at R6. Yield was determined by harvesting the center two rows of each plot with a plot combine and adjusted to 13% moisture content. At harvest, subsamples were collected for grain nutrient concentration analyses. Analysis of variance (ANOVA) was computed for traits using the Lmer function of R. Means were separated at an alpha value of 0.05 Tukey's HSD.

Regardless of the amount and time of application, R6 tissue leaf sample analysis showed no significant differences in sulfur (Figure 4) and phosphorus (Figure 5) present in the leaves. However, location, amount, and time of the application significantly influence the leaf potassium level at R6 (Figure 6). Fall applied 240 lbs K resulted in the highest K concentration in the leaf tissue at Stoneville. While in Starkville, spring applied numerically outperformed that of fall in the level of leaf tissue K at higher rates. The analysis of grain nutrient concentration showed that only one test in each site (S in Stoneville, K in Starkville, and P in Brooksville) in the study had significant differences (Figure 7-Figure 9). In Stoneville, the spring 20 lbs/ac and fall 40 lbs/ac had the highest grain S concentration (Figure 7). All treatments except fall 10 lbs/ac were significantly different from the check. In Starkville, all K-applied treatments were significantly different from the check (Figure 8). The highest grain K concentration was found with the spring 180 and 240 lbs/ac treatments. At Brooksville, all P-applied treatments were not statistically different from the check except fall applied 60 lbs/ac (Figure 9). The fall applied 60 lbs/ac also had the lowest grain P concentration. Significant differences in yield were only found in the Starkville K (Figure 10) and Brooksville P (Figure 11). In the Starkville site, the spring applied 120 and 180 lbs/a K and fall 180 and 240 lbs/a K were significantly different from the control check (Figure 10). There were no yield differences in all P-applied treatments, and the check except fall applied 90 lbs/ac, which had the lowest yield in Brooksville (Figure 11).

Objective 3:
The field trial was conducted in Brooksville, MS. This study consists of three treatments (1. A no wheat control, 2. Wheat broadcast followed by bedding, and 3. Bedding followed by broadcast wheat) laid out as a randomized complete block design with four replications. Wheat was broadcast (to mimic aerial application) at the rate of 50 lbs/ac. Plots for this study were 25.3 ft × 40 ft long. Data were collected on bed height pre-planting and post-harvest, wheat stand counts in-furrow and on-bed, wheat/weed dry biomass in-furrow and on-bed, soybean stand counts, and yield. Soil moisture data were also collected twice at three soil depths (1.5, 3, and 4.5 inches) during drought spells in the season.

Broadcast then bedding had a higher wheat stand on top of the bed than the bed then broadcast treatment. However, the bed then broadcast treatment has the highest wheat stands in the furrow (Figure 12). There was no statistical difference in wheat biomass on the bed and in the furrow in both the broadcasting then bedding and the bed then broadcast treatment. Both treatments showed a statistical difference from the control check (Figure 13). Post-emergence soybean stand counts showed no statistical difference between the three treatments (Figure 14 and Figure 15). There were no significant differences between treatments at any of the three depths where moisture was taken (Figure 16). Planting soybean through wheat biomass did not significantly affect soybean yield (Figure 17).

Impacts and Benefits to Mississippi Soybean Producers
During the planting season, MS soybean producers are under pressure to plant as much acreage as possible quickly due to calendar and weather constraints. Many farmers, especially those targeting early production systems, fail to plant at the critical window, realizing a negative effect on potential yield. Preliminary results show that we can plant faster without a yield penalty. We expect that planting more acreage within the critical planting window will increase whole-farm yield. Speed also reduces labor hours and allows for more time spent on other management responsibilities.

Furthermore, improving fertilizer use by changing the application timing and rate could be a key to reducing cost and maintaining more fertilizer in the targeted area. We have also noticed a growing adoption of cover crops across the United States. However, we are concerned that Mississippi might fall behind in this trend due to a shortage of cover crop establishment methods. We aim to determine effective establishment methods for bedded systems that do not require excessive post-harvest fieldwork.

End Products–Completed or Forthcoming

Completed

1. Olomitutu, O. E., Mulvaney, M. J., Lowe, W. J., Bryant, C. J., Wallace, J., Harper, N., & Shavers, G. M. (2023). Advanced Planting Technology for Soybean in Mississippi [Abstract]. ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO. https://scisoc.confex.com/scisoc/2023am/meetingapp.cgi/Paper/149224.
2. Shavers, G. M., Mulvaney, M. J., Olomitutu, O. E., Wallace, J., Hilyer, T., Bryant, C. J., & Reed, V. (2023). Fall Vs. Spring Fertilizer Application in Mississippi [Abstract]. ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO. https://scisoc.confex.com/scisoc/2023am/meetingapp.cgi/Paper/149889.
3. Shavers, G. M., Mulvaney, M. J., Olomitutu, O. E., Wallace, J., & Hilyer, T. (2023). Cover Crop Establishment Methods for Soybeans on Beds [Abstract]. ASA, CSSA, SSSA International Annual Meeting, St. Louis, MO. https://scisoc.confex.com/scisoc/2023am/meetingapp.cgi/Paper/151054.
4. Olomitutu, O.E., Mulvaney, M.J., Lowe, J.W., Bryant, C.J., Wallace, J., Harper, N., Dhillon, J., Shavers, G., and Hilyer, T. (2024). Advanced planting technology for soybean in Mississippi. North Mississippi Research & Extension Center Producer Advisory Council. Poster. Feb. 15, 2024.
5. Shavers, G., Mulvaney, M.J., Olomitutu, O.E., Hilyer, T., Wallace, J., Reed, V., and Bryant, C. (2024) Methods for establishing cover crops in bedded systems. North Mississippi Research & Extension Center Producer Advisory Council. Poster. Feb. 15, 2024.
6. O. E. Olomitutu, M. J. Mulvaney, J. Dhillon, W. J. Lowe, C. J. Bryant, J. Wallace, N. Harper, G. M. Shavers, and T. Hilyer. (2024). How Fast Can We Plant Soybean in Mississippi? ASA Southern Branch Meeting. Poster. February 2-6, 2024. Atlanta, Georgia, USA.
7. G. M. Shavers, M. J. Mulvaney, O. E. Olomitutu, T. Hilyer, and J. Wallace. (2024). Methods for Establishing Cover Crops in Bedded Systems. ASA Southern Branch Meeting. Poster. February 2-6, 2024. Atlanta, Georgia, USA.
8. G. M. Shavers, M. J. Mulvaney, O. E. Olomitutu, T. Hilyer, J. Wallace, C. J. Bryant, and V. Reed. (2024). Soybean Response to Fertility Timing in Mississippi. ASA Southern Branch Meeting, February 2-6, 2024. Atlanta, Georgia, USA.
9. Mills, Brian, Mike Mulvaney, Wes Lowe, and Oluwaseyi Olomitutu. “Planting Date: The Need for Speed.“ Southern Ag Today 4(12.3). March 20, 2024. https://southernagtoday.org/2024/03/20/planting-date-the-need-for-speed/.

Forthcoming

The following products are anticipated:

1. MS Thesis, Noah Harper (Dr. Wes Lowe, major professor).
2. Peer-reviewed publication, Agronomy Journal in 2024

Future research questions that may be addressed in the future include:

1. Can faster speeds make growers more resilient to climate change?
2. If we can get more even stands, can we reduce seed rates?
3. What do we need to do when planting into residue at high speed?

4. Downforce: Static or dynamic mode. Which is more important at high speeds?
5. Which components of advanced planting technology are necessary for soybean production, and which are unnecessary?
6. Can we combine broadcasting cover crops with soybean harvest?
7. How effective is a drill to plant cover crops on beds?

Two graduate students are being trained on this, and findings from this project will be presented in extension talks, bulletins, posters, presentations, and peer-reviewed publications.

Table 1. ANOVA of soybean plant stand, plant spacing variability (standard deviation), and yield response to planting speed at three locations in MS during 2023.

Location	Response	Effects	DF	Fvalue	ProbF
Brooksville	Plants/ac	Speed	3	6.23	0.0085
	Std. Dev. of plant spacing (in)	Speed	3	5.84	0.011
	Yield (bu/ac)	Speed	3	0.33	0.81
Stoneville	Plants/ac	Speed	3	1.84	0.21
	Std. Dev. of plant spacing (in)	Speed	3	13.3	0.0011
	Yield (bu/ac)	Speed	3	0.35	0.79
On-farm	Plants/ac	Speed	2	0.72	0.53
	Std. Dev. of plant spacing (in)	Speed	2	8.09	0.019
	Yield (bu/ac)	Speed	2	1.71	0.26

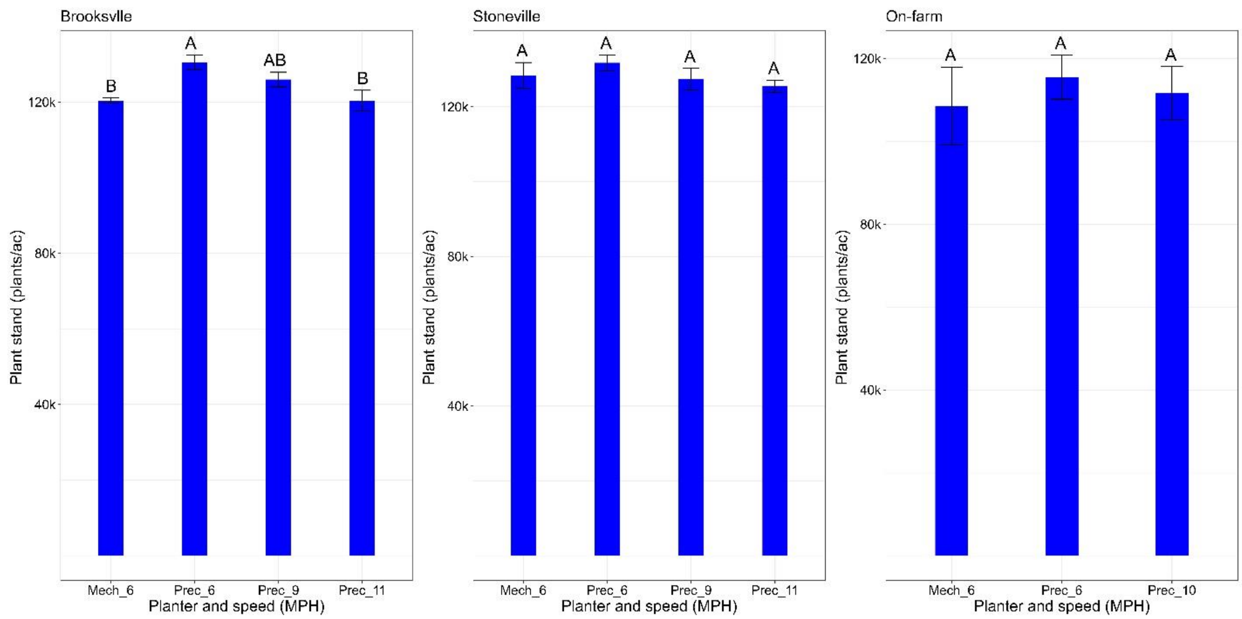


Figure 1. Soybean stand using mechanical and precision planters at various planting speeds at various locations in MS during 2023. Different letters above means indicate significantly different response (LSD = p<0.05). Mechanic planter (Mech); Precision planter (Prec); Actual ground speed (6, 9, 10, 11).

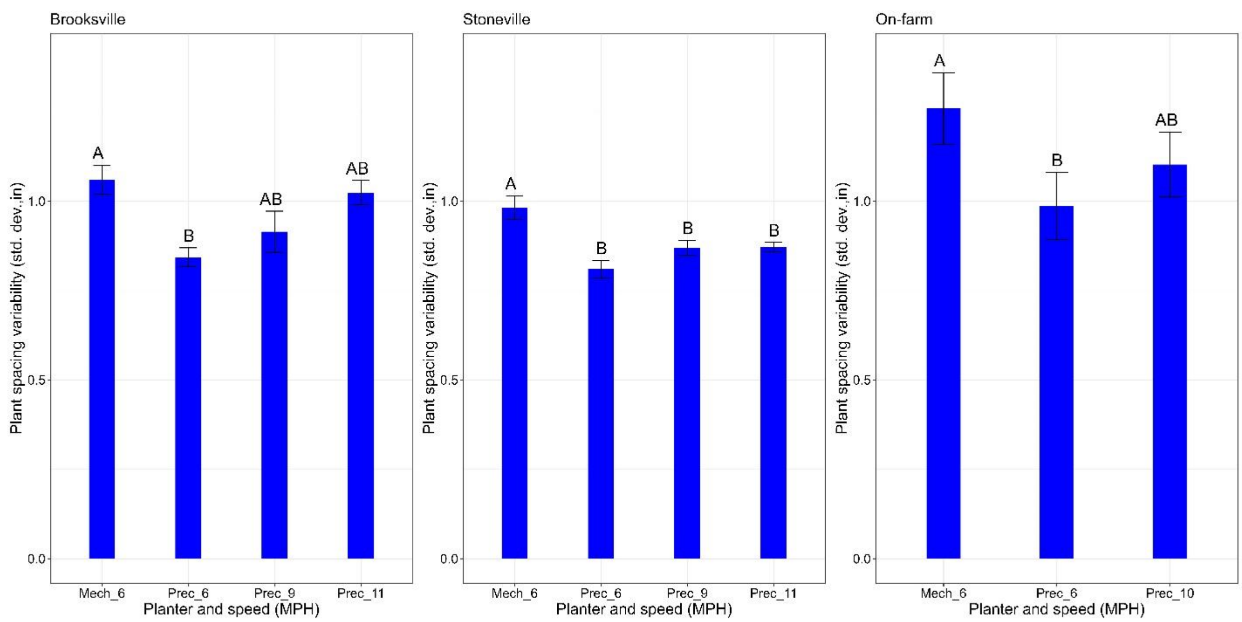


Figure 2. In-row plant spacing standard deviation at three locations in MS during 2023. Different letters above means indicate significantly different response (LSD = p<0.05). Mechanic planter (Mech); Precision planter (Prec); Actual ground speed (6, 9, 10, 11).

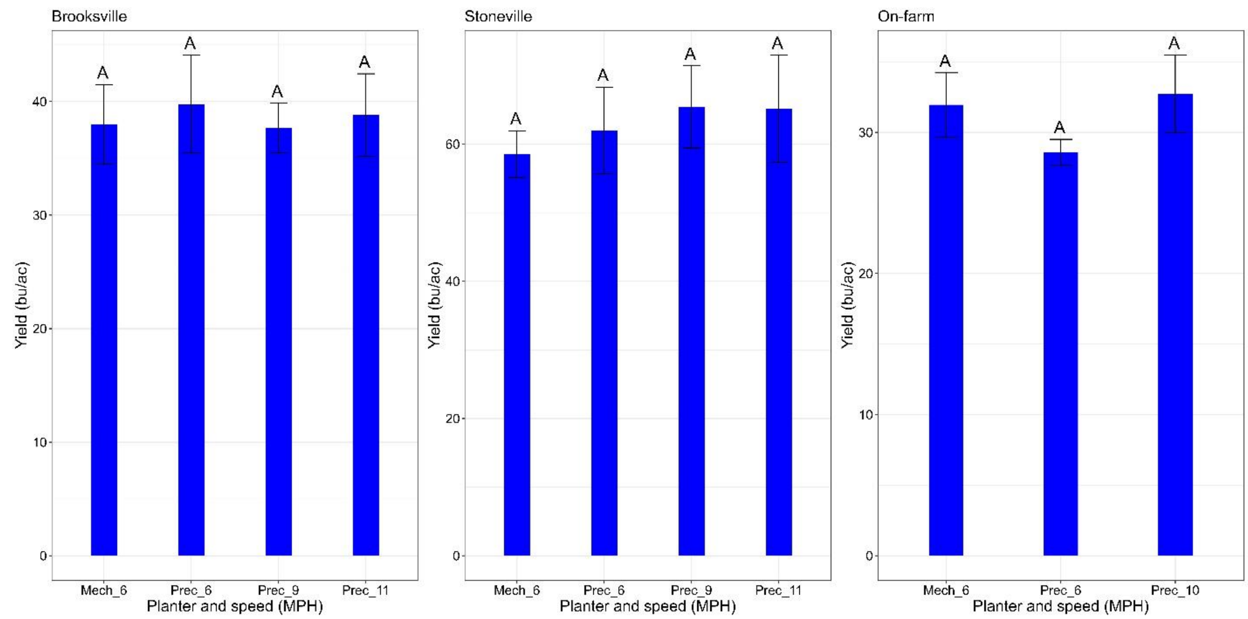


Figure 3. Soybean yield using mechanical and precision planters at various planting speeds in various MS locations during 2023. Different letters above means indicate significantly different response (LSD = p<0.05). Mechanic planter (Mech); Precision planter (Prec); Actual ground speed (6, 9, 10, 11 mph).

Table 2. Planter technology return on investment (ROI) comparing the net returns of a mechanical planter to a precision planter without downforce.

	Mechanical (5 MPH)	Precision (9 MPH)	Diff
Days of Planting	23	13	
Optimal Start Date	Apr. 9	Apr. 14	
Yield Produced (bu)	139,468.78	141,813.80	2,345.02
Revenue ($)	$1,673,625.41	$1,701,765.65	28,140.25
Costs per acre	$19.20	$15.81	(3.38)
Total Costs ($)	$38,392.62	$31,625.11	(6,767.51)
Net Returns ($)	$1,635,232.79	$1,670,140.54	$34,907.76

Table 3. ANOVA of interval (days) between soybean growth stages by planting date (PD) and seeding rate (SR) at Starkville, Mississippi

Response	Effect	DF	Fvalue	ProbF
PD to VE	PD	3	49.6	<.0001
	SR	3	1.73	0.1776
	PD*SR	9	1.34	0.2501
VE to R1	PD	3	290.21	<.0001
	SR	3	1.36	0.2685
	PD*SR	9	1.02	0.4354
R1 to R3	PD	3	19.28	<.0001
	SR	3	1.39	0.2586

	PD*SR	9	0.97	0.4759
R3 to R6	PD	3	188.14	<.0001
	SR	3	1.46	0.2428
	PD*SR	9	0.73	0.6799
R6 to R8	PD	3	7.86	<.0001
	SR	3	3.59	0.021
	PD*SR	9	0.83	0.5889

Emergence (VE); Beginning bloom (R1); Beginning pod (R3); Full seed (R6); Full maturity (R8)

Table 4. Mean interval (days) between soybean growth stages by planting date (PD) and seeding rate (SR) at Starkville, Mississippi

PD	PD-VE	VE-R1	R1-R3	R3-R6	R6-R8
1-Apr	7	46	16	50	22
21-Apr	13	33	14	53	23
14-May	9	32	16	49	24
7-Jun	6	33	14	42	21

Emergence (VE); Beginning bloom (R1); Beginning pod (R3); Full seed (R6); Full maturity (R8)

Table 5. Analysis of post-harvest data

Effect	Df	Number of Branches/plant	Number of pods/plant	Seed mass/plant (g)	Yield (bu/ac)
			ProbF		
PD	3	0.0004	0.0035	0.0948	<.0001
SR	3	0.0011	0.0013	0.0031	0.8531
PD*SR	9	0.1293	0.3338	0.5868	0.376
Planting date					
1_April		4.5833a	80.9375ab	24.4002a	21.9889b
14_May		4.1875ab	94.6875a	24.0663a	39.1356a
21_April		3.8958b	72.625b	21.6704ab	21.6343b
7_June		3.0625c	69.1042b	19.7046b	39.2463a
Seed rate					
50k		4.6458a	92.6042a	26.5044a	29.866a
80k		4.1458ab	86.5208ab	23.7481ab	31.5386a
110k		3.6875bc	72.3542bc	20.8367bc	30.4159a
140k		3.25c	65.875c	18.7523c	30.1845a

Different letters above means indicate significantly different response (LSD = p<0.05).

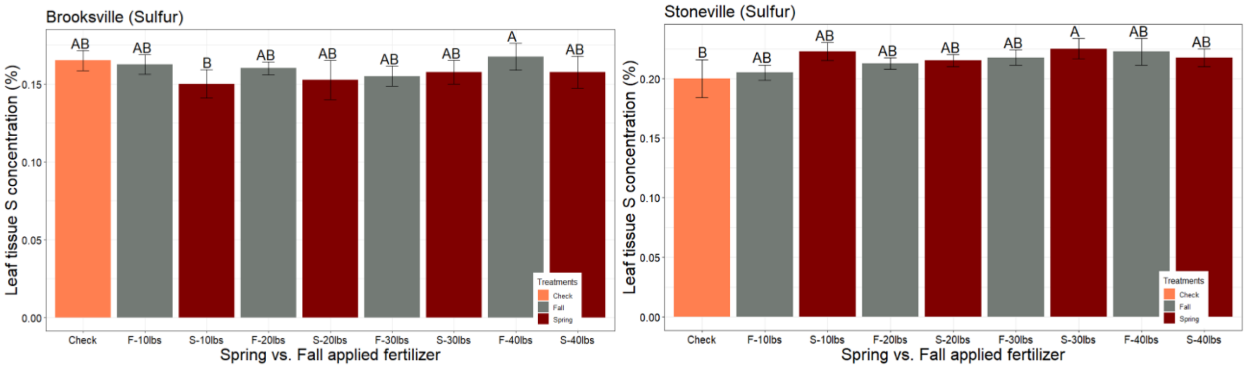


Figure 4. Percentage of sulfur in the upper most leaves at R6 growth stage. Locations included Brooksville and Stoneville, MS. Different letters above means indicate significantly different responses (HSD = p<0.05).

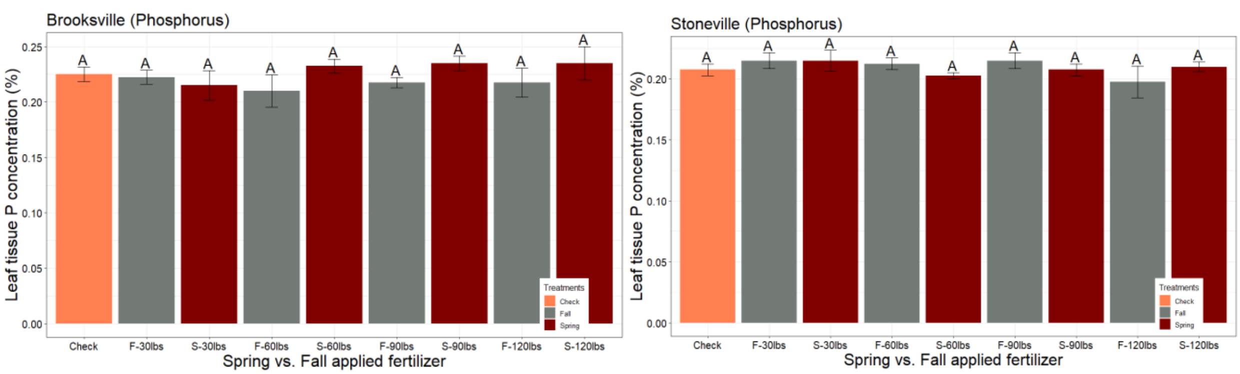


Figure 5. Percentage phosphorus in the uppermost fully developed leaves at R6 growth stage. Locations included Brooksville and Stoneville, MS. Different letters above means indicate significantly different responses (HSD = p<0.05).

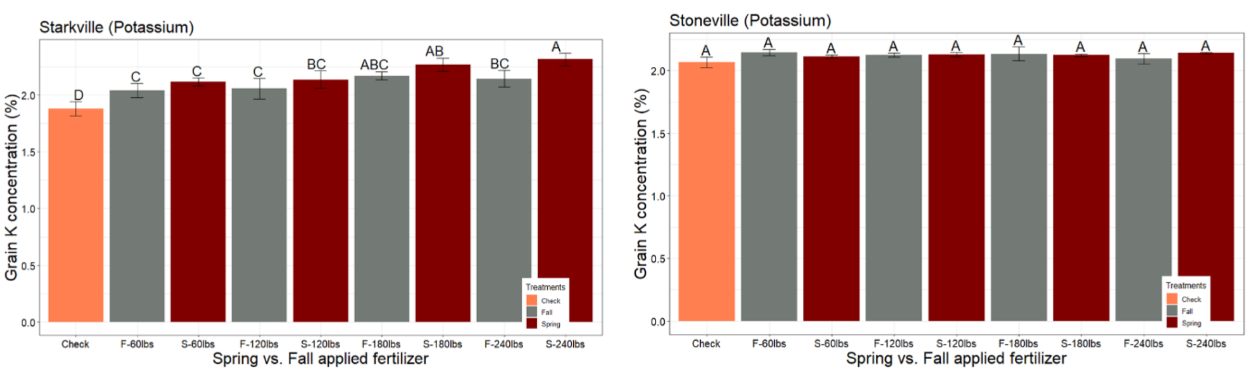


Figure 6. Percentage of potassium in the uppermost fully developed at R6 growth stage. Locations included Brooksville and Stoneville, MS. Different letters above means indicate significantly different responses (HSD = p<0.05).

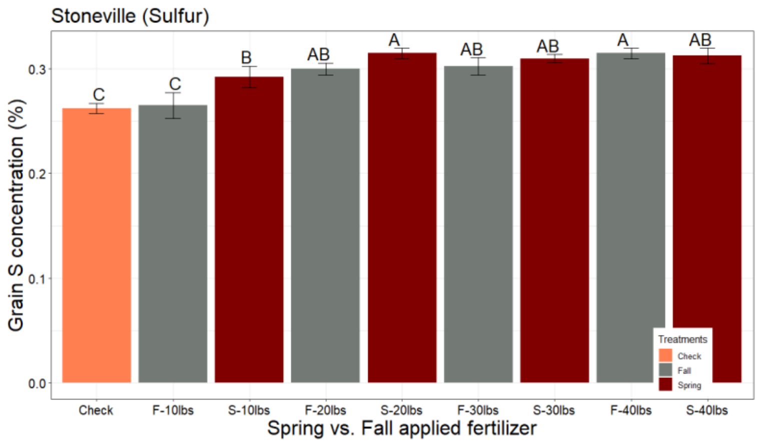


Figure 7 . Grain sulfur (S) concentration as a percentage (%) in Stoneville, MS. Comparing fall vs. spring at different fertilizer rates in pounds per acre (lbs). Different letters above means indicate significantly different responses (HSD = p<0.05).

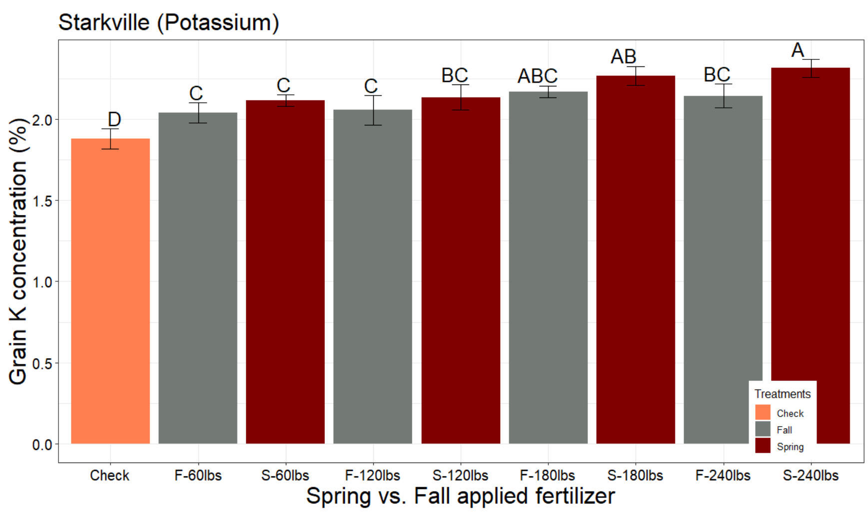


Figure 8. Grain potassium (K) concentration as a percentage (%) in Starkville, MS. Comparing fall vs. spring at different fertilizer rates in pounds per acre (lbs). Different letters above means indicate significantly different responses (HSD = p<0.05).

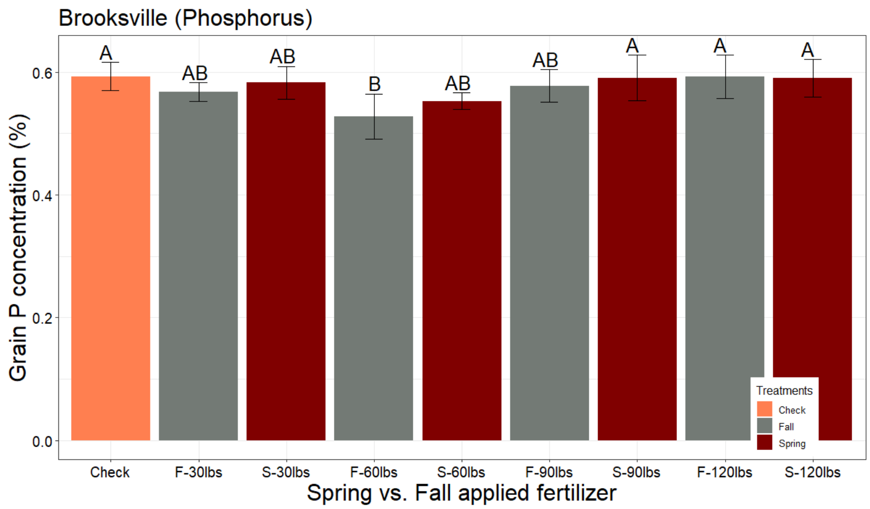


Figure 9. Grain phosphorus (P) concentration as a percentage (%) in Brooksville, MS. Comparing fall vs. spring at different fertilizer rates in pounds per acre (lbs). Different letters above means indicate significantly different responses (HSD = p<0.05).

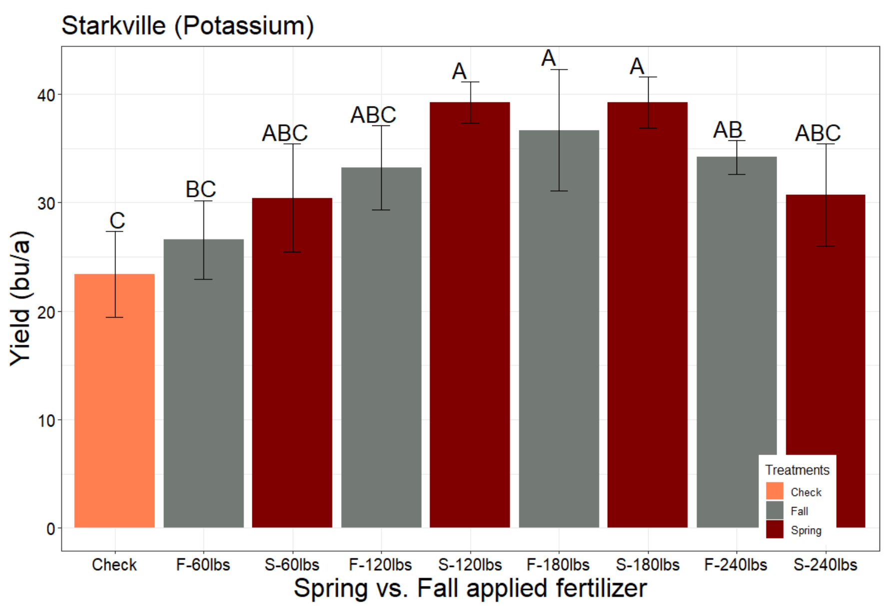


Figure 10. Soybean yield in Starkville, MS comparing fall vs. spring potassium application at different rates in pounds per acre (lbs). Different letters above means indicate significantly different responses (HSD = p<0.05).

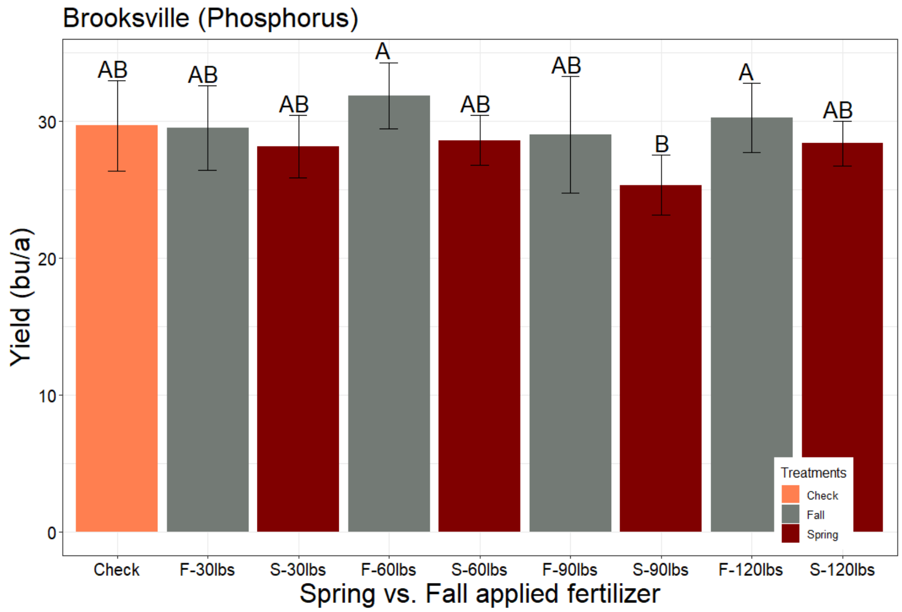


Figure 11. Soybean yield as bushels per acre (bu/a) in Brooksville, MS. Comparing fall vs. spring phosphorus application at different rates in pounds per acre (lbs). Different letters above means indicate significantly different responses (HSD = p<0.05).

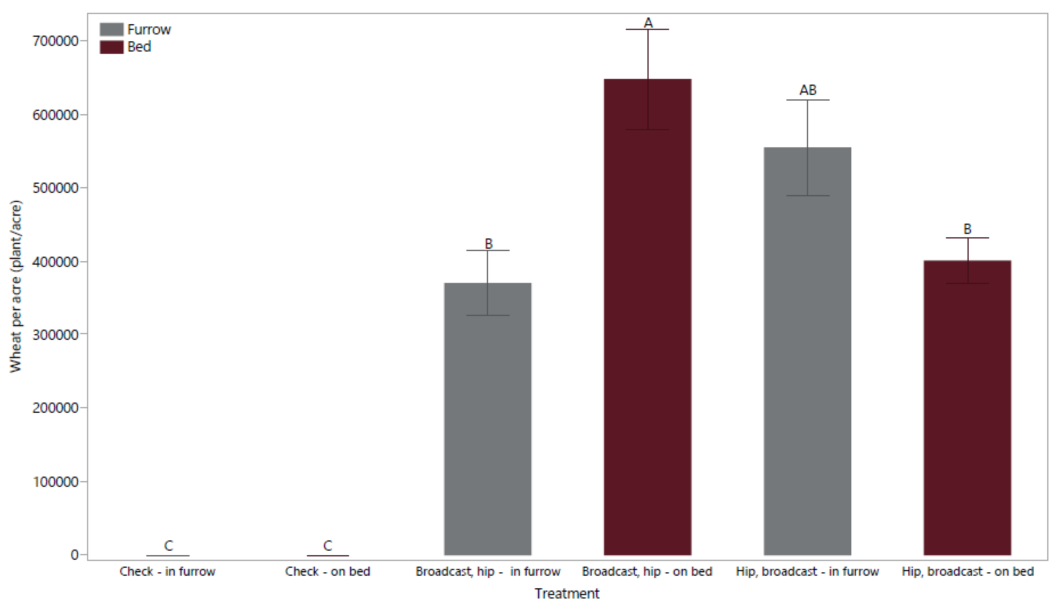


Figure 12. Wheat stand comparing broadcast then hipped with hipped then broadcast. Measurements taken in furrow and on bed. Different letters above means indicate significantly different responses (HSD= p<0.05).

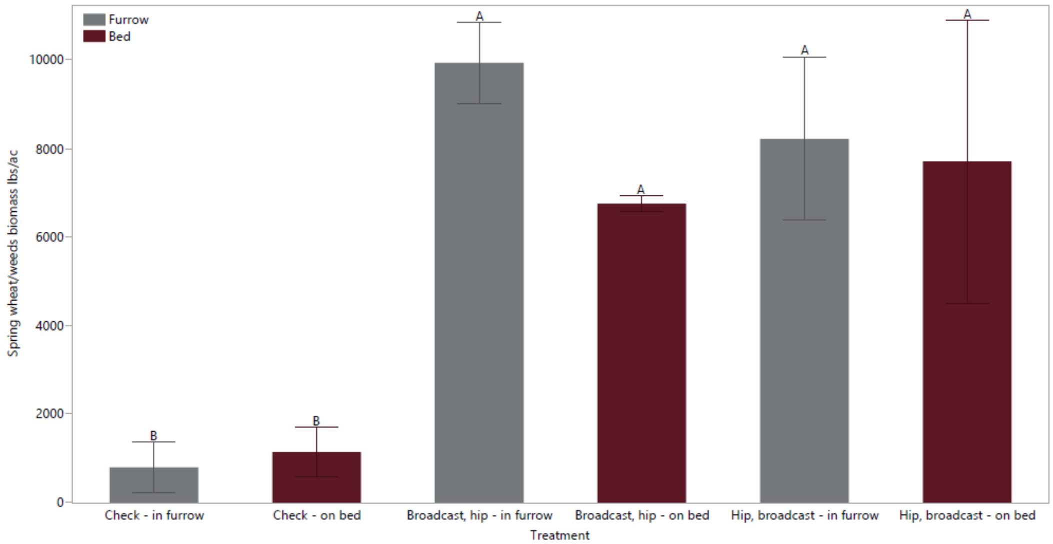


Figure 13. Wheat/weed biomass comparing broadcast then hipped with hipped then broadcast. Measurements taken in furrow and on bed. Different letters above means indicate significantly different responses (HSD = p<0.05).

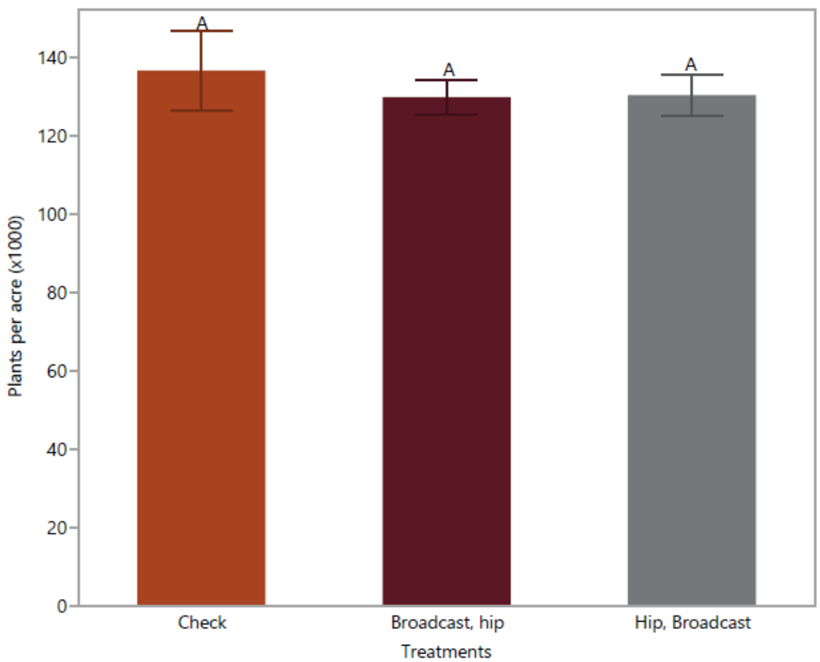


Figure 14. Soybean stand comparing broadcast then hipped with hipped then broadcast. Different letters above means indicate significantly different responses (HSD = p<0.05).

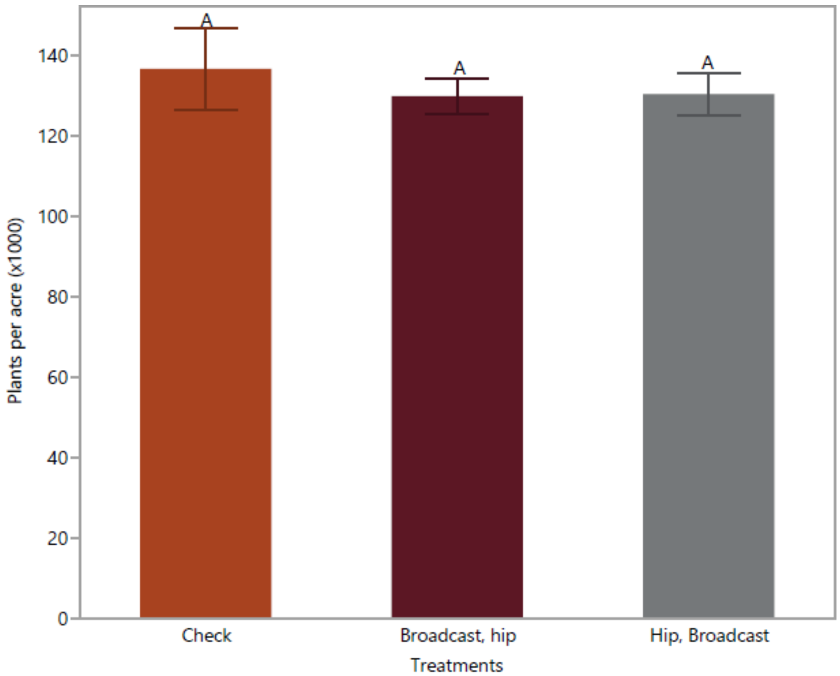
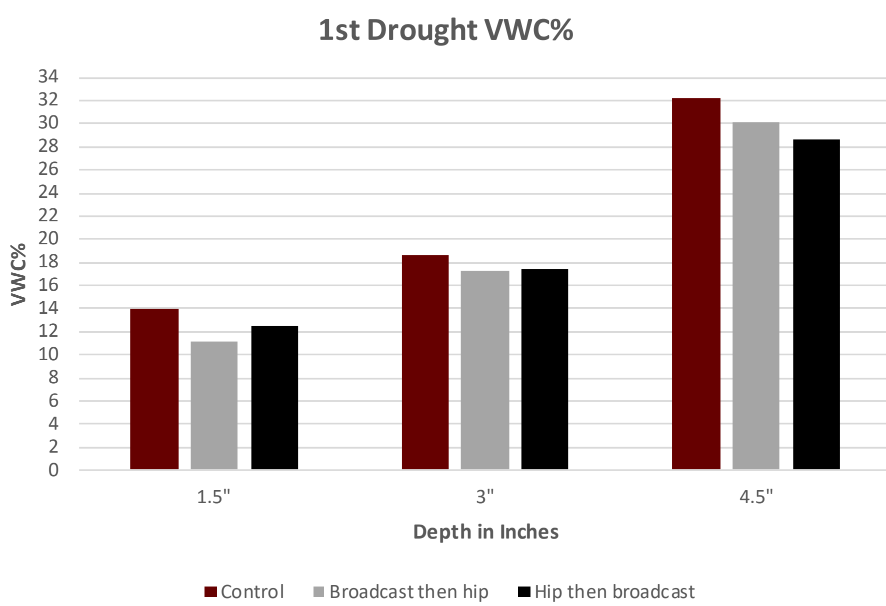


Figure 15. 2023 soybean stand response to different cover crop establishment strategies in Brooksville, MS. Different letters above means indicate significantly different responses (HSD = p<0.05).



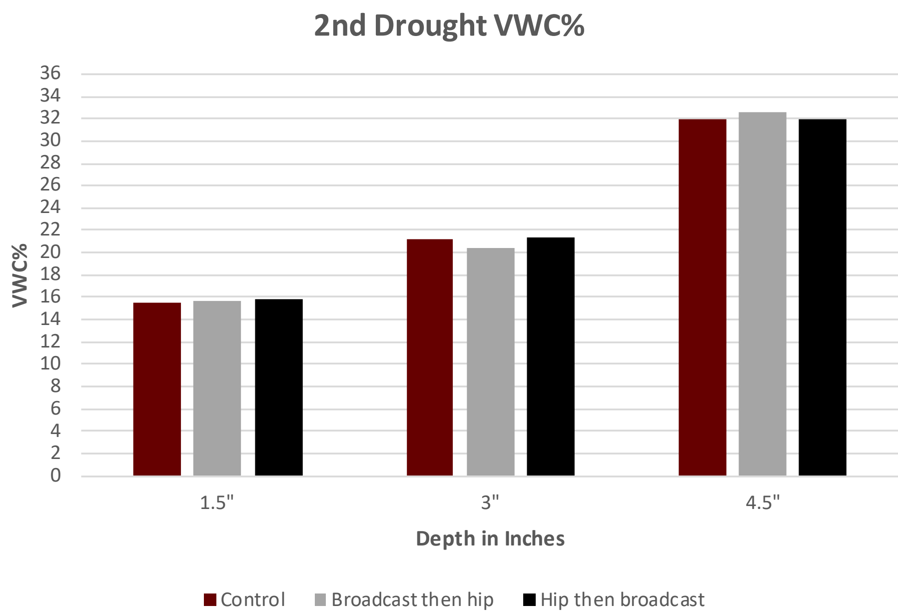


Figure 16. Volumetric water content (VWC) at three depths during two different drought periods as measured by time domain reflectometry (TDR) in Brooksville, MS.

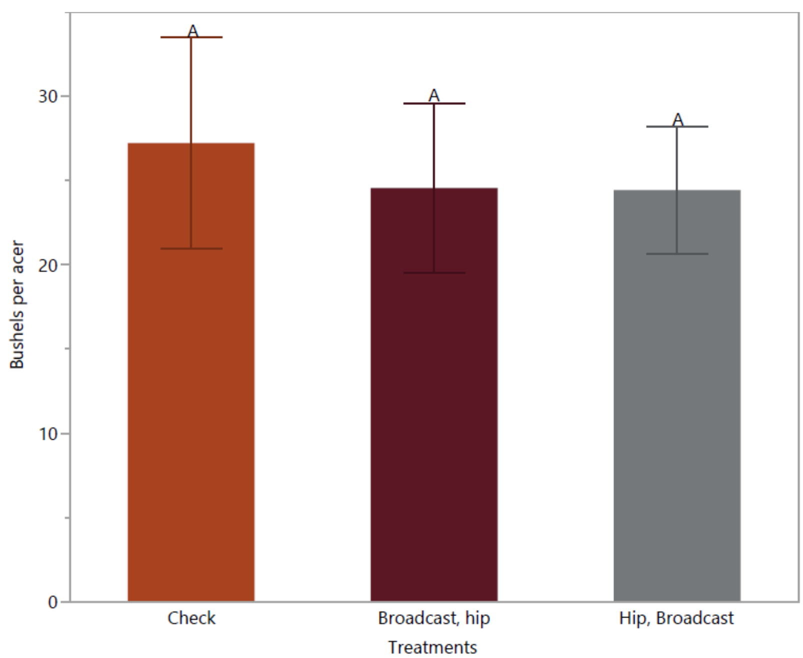


Figure 17. Soybean yield comparing broadcast then hipped with hipped then broadcast. Different letters above means indicate significantly different responses (HSD = p<0.05).