MISSISSIPPI SOYBEAN PROMOTION BOARD
PROJECT NO. 06-2018
2018 ANNUAL REPORT

Project Title: Stepwise Evaluation of High Technology Production Systems by Omission Research Techniques

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ANNUAL REPORT OF PROGRESS/ACTIVITY

Soybean production in Mississippi was first reported in 1924 when 45,000 acres were planted, 21,000 acres harvested for grain with an average yield of 8.0 bu/acre. Soybean was initially brought into this country as a protein rice hay crop and was used that way until well into the 1950's. The first one million acre crop was harvested in 1961 and averaged 22.5 bu/acre. The peak acreage reached 4.1 million acres harvested in 1979 with an average state yield of 29.0 bu/acre, the largest state average in Mississippi history. State acreage declined after that and by 1990 harvested acreage dropped to 1.9 million acres. After the turn of the century, harvested acres have dropped to 1.12 million acres in 2001. In the last five years, soybean plantings have exceeded 2.0 million acres and in the same five years have had average state yields over 45 bu/acre. In 2014 and 2017, average soybean yields in the state were 52.0 and 53.0 bu/care, respectively and reached a record 54.5 bu/acre in 2018 on 2.19 million harvested acres. Grain crop rotations (corn and soybean) have become a standard on many farms across the Mid-south.

Much of the yield advantage has come with the adoption of the Early Soybean Production System (ESPS) that has successfully moved planting dates earlier into late March and April, moved to earlier maturity groups, and profited from irrigation even in an area receiving greater than 50 inches off annual rainfall. While annual rainfall is plentiful, the distribution of timely events often is not. New technologies have seed-carried traits for insect, weed and disease control that have increased seed cost but decreased other application and material cost. While much of the country has moved to narrower row spacings (30 inches or less) the Mid-south has not made the shift. Much of the irrigated production has continued to be grown on raised beds that facilitate getting water off the field (drainage) and well as getting water on the field (irrigation). The decline in soybean acreage was generally on fields less suite to above average yields that was better suited to trees and other mechanisms of conservation reserve. In order to take advantage of early planting and potential for narrower rows, many growers in the Mid-south adopted twin-row production (planting two rows on the same bed) systems in various forms. Having two rows that are 8-10 inches apart on 38-40 inch raised beds have in effects created the 30-in rows without every row being 30 inches apart.

As soybean yields increased, the amount of nutrients contained in that seed (per acre basis) has also increased and leaves the field at harvest. For many years, much of the soybean acreage was not fertilized with most fertilizer money going toward cotton being grown on the sandier soils. As yields increased and nutrient uptake and removal also increased per acre, greater emphasis has been placed on soil sampling and following recommendations. Soil pH, phosphorus, and potassium adequacy are essential for optimum yields.

Many others are important for achieving optimum yields with many ”automatic” inputs used without scouting

or testing. The purpose of this research project is to evaluate some of the automatic inputs including fungicide application, P and K, N and S, and dessication. Making applications when not needed adds to the cost of production. Input costs are better utilized when needed and offer greater potential for return on investment. Planting equipment available to producers has been improved to insure more uniform planting and more equal spacing between plants. Maintaining optimum yields and reducing input costs lead to profitability. The whole plots for the main studies are based on seeding rates (8 or 12 seed/ft) plant in single-row or twin-row planting patterns.

Objective 1: Determine through stepwise (addition or removal) integration the value of specific inputs to both agronomic and economic productivity of soybean.

Multiple-year field studies were initiated in the spring of 2017 on the Delta Research and Extension Center near Stoneville, MS to evaluate, by stepwise omission research techniques, the agronomic and economic impact of technology inputs. Current plot plans (2018) for the studies have been included (Appendix A). The initial goal of the project included a non-irrigated location and it was included in 2018 when a non-irrigated location was established at the North Mississippi Research and Extension Center (NMREC, Verona, MS). The bases for the project involves single-row (SR) and twin-row (TR) planting at a low plant population (~8 seed/ft) and at a high plant population (~12 seed/ft) on either a 40-in bed spacing (DREC) or 38-in bed spacing (NMREC). The actually seeding rate varies some depending upon the planter used. The SR-L, SR-H, TR-L, and TR-H constitute the whole plots with fungicide, dessication, fertilizer P-K, and fertilizer N-S as the subplots. The priority of the input was based on discussions with the state soybean specialist. These treatments were also based on practices deemed routine without scouting. (***SEE*** Plot plans for complete treatment list).

Soybean cultivar “Credenz 4748 LL” was planted on 30 April (DREC) on a stale seedbed that had been rowed up in the fall of 2017. Singe-row planting was with a John Deere planter with seeding rate calibrated prior to planting (SR-L = 104,500 seed/acre and SR-H = 156,800 seed/acre). Twin-row planting was completed with a Monosem twin-row planter and seeding rates based on the Monosem Appication (App) for smart phones. The row configuration by seeding rates systems were planted as strips across the field in order to maintain drainage and irrigation channels.

A summary of rainfall totals (daily) and rainfall events has been included in Table 1 with 77.95 inches of rainfall recorded between 1 January 2018 and 31 December 2018. The total rainfall events in each month and events with greater than one inch falling in a 24-hr period are also included. May, June, and July rainfall was below normal during that portion of the growing season. Feb-Mar rainfall totaled nearly 23 inches prior to planting. Aug-Sept rainfall exceeded 16.5 inches which resulted in harvest delays. This is particularly important as dessication was a component and normally is timed with planned harvest within 10-14 days. Aug-Dec rainfall saw only October with below normal rainfall. Total rainfall for the 5-month period was 37.2 inches (15 inches above normal). Below normal rainfall could impact soil moisture recharge but that can easily be over come by spring rainfall in the Mid-South. Above normal rainfall can completely recharge the soil moisture profile but often leads to run-off carrying both soil and nutrients. Also of interest was the fact that 144 days of measurable precipitation fell in 2018 with 24 events of > 1 inch (Table 1).

With respect to th research field, once the base whole plots were established, the area was divided into two studies, 18-SB34 (Addition) and 18-SB35 (Subtraction). The subplots were then set up within each study. Phosphorus (P) and potassium (K) was applied at rates of 100 lb P_2O_5/acre and 100 lb K_2O/acre, respectively on 7 May. Ammonium sulfate at 100 lb/acre was also applied to selected treatments per protocol, also on 7 May. All fertilizer additions were made from pre-weighed bags applied as a simulated broadcast application (hand-applied) to the surface following the method preferred by producers. Fungicide application to selected plots was made on 11 July (R4) utilizing Quadris Top® SBX applied at 7.5 oz/acre. This fungicide offers broad-spectrum preventive and curative disease control with two different modes of action. Application was broadcast-applied by ground applicator. The dessication treatment was applied on 30

August (R7) using Gramoxone @ 16 oz/acre (product has 15 day pre-harvest interval) with anticipated harvest two weeks later. Soybean harvest should have occurred within the 14-21 days following dessication but was delayed a couple of weeks due to wet conditions. Soybean plots were harvested on 8 and 9 October, later than planned. This was the second year in a row where soybean harvest was delayed due to weather conditions. Unfortunately, producers have no influence on the weather and are hoping for favorable conditions for harvest following dessication.

The center two rows of each 4-row plot were harvested with sub-samples collected at the time of harvest. Harvest moisture, bushel test weight and Seed Index (100-seed weight) were determined from the samples. Also, with the delay in harvest and the use of fungicide as a treatment, purple stain numbers were determined on the three 100-seed samples used to determine Seed Index. This was done by visual observation and counting of damaged seed based on the recommendations of Drs. Allen and Wilkerson (Plant Pathology). Grain yields were adjusted to 13% moisture for all soybean samples. The data was then subjected to an Analysis of Variance. If the interactions were not significant, then the error terms were pooled (error estimate are the same) and LSD calculated for all treatments (Tables 2 and 4). Soil samples were collected from each plot in both studies. The samples were collected, dried, and ground. The samples were submitted the Southern Soils Laboratory in Yazoo City, MS with turn-around in less than a week. Since N, P, K, and S are components of the study no additional fertilizer will be applied until the study has been completed. Since this area is irrigated from a well, not lime should be required but will be added if needed

YIELD RESULTS AND DISCUSSION

In the addition study (18-SB34), treatment grain yields ranged from a low of 49.7 to a high of 56.4 bu/acre with a field average of 53.2 bu/acre with averages shown in Table 2 (averaged across 4 replications). A summary main effects (whole plots treatments and subplots treatments) are shown in Table 3. The whole plot by subplots interaction was not significant for yield, bushel test weight, or Seed Index (Table 3). Overall grain yields as not significantly affected by seeding rate (8 vs 12) or planting pattern (SR vs TR). Seed Index was impacted by Planting pattern and seeding rate. The SR planting system had a higher Seed Index and in either system, 12 seed/ft was high than 8 seed/ft.

With respect to subplot treatments averaged across PPxSR, the addition of any factor resulted in higher grain yields bu had no effect on bushel test weight. Seed Index was also significantly higher for any treatment combination compared to the untreated (Table 3).

Purple seed stain is the result of Cercospora leaf blight (*Cercospora kikuchii*) presence and may reduce quality and marketability of soybean. The range in affected seed (average of three 100-seed lots) was from a low of 0.7 to a high of 8.0% with a test average of 2.9%. Statistical analysis will determine the significance of the infection and will be included in future reports. This may only be a phenomena for 2017. No data has been included for this component of the research. Timely harvest, should lead to decreasing the incidence of this disease.

In the second study (18-SB35), the omission study, the harvest and sampling were the same as previously addressed. Soybean grain yields averaged across replications ranged from 50.3 to 58.1 bu/acre with a test average of 53.8 bu/acre when adjusted to 13% moisture. Both 18-SB34 and 18-SB35 had nearly the same average yield when corrected to 13% moisture. The bushel test weight ranged from 52.48 to 54.49 lb/bu with a test average of 53.62 lb/bu and no influence from any of the treatments. Seed Index ranged from 13.2359 to 14.3440 g/100-seed with a test average of 14.1692 g/100-seed. The purple seed stain levels were just slightly lower than observed in the other test. When evaluating all treatment combinations (Table 4), the whole plot error term and the subplot error were pooled as the difference was not significant indicating that the error terms are estimating the same natural variation (indicating a uniform field) and were pooled for the treatment analysis. A split plot design was used in order to facilitate planting and to maintain drainage and

irrigation channels. With respect to all treatments (Table 4), there was no significance in either grain yield or bushel test weight. Similar to the first study, the additional treatment inputs improved Seed Index.

Main effects have been summarized in Table 5, with no significant interaction between whole plots and subplots. Grain yield was significantly impacted by planting system (Planting Pattern [PP] and Seeding Rates [SR]) with the SR-8 yield lower than the other three systems. With respect to the SR system, SR-12 was 2.2 bu/acre higher yielding (< 5%) while there was no difference in the TR system.

All subplot treatments improved yield compared to the untreated system with the biggest advantage to fungicide alone (3.0 bu/acre increase) or fungicide+desiccant. Bushel test weight and Seed Index were both impacted by the PP x SR whole plots and subplot treatments (Table 5). With some variability, the highest Bushel test weight was found with TR-8 compared to the lowest with SR-8. Single-row planting at 12 seed/ft was significantly higher with respect to Seed Index.

Planting Pattern X Seeding Rate X Planting Date Study

The whole plot component of the previously discussed research involves single-row and twin-row planting systems with two seeding rates, 8 and 12 seed/ft of row (104,500 and 156,800 seed/acre). In order a further evaluate this component of the initial studies, a third study was designed and implemented in 2017 and expanded in 2018. This study was a factorial arrangement of row configuration (single-row [SR] vs twin-row [TR]) with four seeding rates. Initially, 8 seed/ft (104,500 seed/acre), 10 seed/ft (130,700 seed/acre), and 12 seed/ft (156,800 seed/acre) were included and then 6 seed/ft (78,400 seed/acre) was added. To further advance the research an early and late planting date was included. The SR areas were planted with a John Deer planter while the TR area was planted with a Monosem Twin-row planter. The early area was planted 2 May 2018 with the late planting on 6 June with the same planters.

Both areas were and harvested 8 October 2018. The cultivar was held constant with the other studies an utilized Credenz 4748 LL (Bayer, now BASF). As part of the PhD project, canopy closure was monitored as well as plant stands and plant samples. At harvest, plant height was determined. From plant samples, nodes and pods were counted and summarized. At harvest, sub-samples were again collected for lab determination of harvest moisture, bushel test weight, and Seed Index. The study included the eight treatments and eight replications. Results from these studies are summarized in Table 6-9. In the previous year, grain yields were not significantly reduced when seeding rates were reduced from 12 to 8 seed/ft (156K to 105K) so an even lower seeding rate was included. At the first planting date (SB33E) Table 6, grain yields when adjusted to 13% moisture, ranged from 47.2 to 52.0 bu/acre with an overall mean of 49.3 bu/acre. Grain yield, adjusted bushel test weight and Seed Index were not significantly affected by seeding rate an row configuration (SR vs TR) (Table 6). With no significant interaction, main effects were examined. Planting pattern (SR vs TR) had no significant impact on grain yield, bushel test weight or seed weight (Table 6) while the seeding rates (averaged across planting patterns and replications, n=16) were not significantly affected. Grain yields were 48.6, 48.8, 49.1, and 50.8 bu/acre for the 6, 8, 10, and 12 seed/ft rates, respectively. The results suggest that seeding rates could be reduced with comparable yields keeping in mind that stand uniformity is critical. Table 7 includes a summary of harvest moisture, plant height, main stem nodes, and branch nodes. Harvest moisture was obtained from samples taken a harvest while the remain data came from random plant samples taken a harvest from the adjoining rows. Harvest moisture was not affected by treatments as would be expected since the harvest was delayed due to wet conditions in October. Main stem nodes were very consistent across planting patterns and seeding rates and averaged about 15 nodes/plant. Plant height from the earlier planting averaged 35.9 inches (91.2 cm). Branch nodes were higher as expected with the lower seeding rates but a great deal of variability was evident (CV = 52.6%). In examining the main effects (Table 7) for planting pattern, harvest moisture, main stem nodes, and plant height were no affected by planting pattern while the average branch nodes was higher in the TR configuration. With respect to seeding rates averaged across the planting patterns, only branch nodes decreased with increased seeding rates.

A second expansion in 2018 occurred in the seeding rate by planting pattern research where a second later planting date was introduced in 2018. Researchers were interested in whether late planting could be affected by either seeding rates or planting patterns. The late planting study (SB33L) was planted 6 June and also harvested on 8 October. Soybean maturity is related to a photo-period response rather than a planting date effect. This helps to explain why even though planting dates were mor ethan a month apart, harvest dates were the same. Results from the later planted study are included in Tables 8 and 9. Average grain yield was 33.4 bu/acre down about 16 bu/acre compared to the earlier planting. Bushel test weight and Seed Index were higher for the later planting study. Interaction effects were almost significant with respect to yield (Prob. > F = 0.0545). When looking at interaction yields, the range was 25.7 to 44.2 bu/acre with an overall field average of 33.4 bu/acre. If the main effects are considered, TR yields were 35.0 bu/acre while SR yields were 31.7 bu/acre. Bushel test weight was higher for TR planting but lower for Seed Index (Table 8).

Harvest moisture was impacted by treatments but main stem nodes, plant height and branch nodes were node. However, when evaluating main effects, harvest moisture was significantly lower in the TR system and that concurs with filed observations of TR soybean dropping leaves earlier. The TR soybean when averaged across seeding rates did result in taller soybean in the TR system (33.4 in compared to 31.7 in). At the later planting seeding rates didnot affect harvest moisture, plant height , main stem nodes or branch nodes (Table 9).

Both studies will be repeated in 2019 on the same soil type.

Objective 2: Evaluate the systems under rain-fed and irrigated conditions.

In 2018, rain-fed (non-irrigated) studies were established on the North Mississippi Research and Extension Center at Verona, Mississippi in coordination with Dr. Dennis Reginelli. Credenz 4748 LL soybean was also planted at Verona on 38-in beds with the equipment available at the station. Some stand issues occurred but an effort was made to salvage as much of the study as possible. Dicamba (expected) injury was observed and has been verified. The drift appeared to come from a farm adjacent to the experiment station. The P-K and N-S treatments were hand-applied on 10 May utilizing pre-weighed bags for each plot. A second herbicide drift and injury occurred and may require a shift in cultivar for the following growing season. The new technologies may offer opportunities for some but have been an issue at the rain-fed location in Verona. The fungicide and dessication treatments were continued even though damage was evident. Fungicide was applied (R4) on 7 August and dessication (R7) on 31 August. Soybean has was started on 10 October but got halted by rain and was completed on 15 October.

Samples were collected at the time of harvest and used to determine harvest moisture, bushel test weight, Seed Index (100-seed weight) and also examined for the incidence of purple stain as the seed stayed in the field much longer than desired. Rainfall in the last five years in the Mississippi Delta has been above normal but not always affecting harvest. There was so much variation in the field as a result of the drift problems, the data was not deemed acceptable for analysis. A concentrated effort will be made in 2019 to avert the problems of 2018. A Pioneer Extend cultivar will be planted in Verona in the 2019 growing season. The studies will also be located farther from the farmer field but did not insure that drift would not be an issue without changing cultivars. While many farmers are having to deal with the drift issues from both dicamba and 2-4D, research can be devastated as was the case at this location. Dicamba drift was also evident at Stoneville during the last two years but was not observed in the research fields. These issues continue to be addressed

Objective 3: Determine the overall importance of input factors over time and from season to season and also evaluate the economic implications

The agronomic and economic evaluation will follow harvest and yield determinations at the end of the season. Soil samples were taken from each plot to monitor changes and levels of nutrients over time. Dr. Larry Falconer has retired from Mississippi State and He was the economist of record. Dr. Steve Martin, Associate Director of Mississippi State University has agreed to help with this project and serve on the graduate committee for Richard Turner. Dr. Falconer's position has been posted and candidates interviewed and will hopefully be filled in the next few months. This will allow for a complete analysis of the inputs and outcomes. Very generally speaking, decreasing seeding rates from 12 seed/ft to 6 seed/ft has not shown a significant yield reduction (uniform stands) and would definitely be a cost saving compared to the higher 12 seed/ft.

Table 1: Rainfall summary for 2018 at the Delta Research and Extension Center, Stoneville, Mississippi. Includes daily and monthly totals and norms.

Delta Research and Extension Center Stoneville, Mississippi RAINFALL (INCHES) JANUARY to DECEMBER - 2018													
Day of Month	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	Jul 2018	Aug 2018	Sep 2018	Oct 2018	Nov 2018	Dec 2018	TOTAL
1	0.00	0.00	0.73	0.00	0.00	0.00	0.00	0.30	0.00	0.00	2.61	0.14	
2	0.00	0.00	0.42	0.00	0.00	0.00	0.04	0.00	0.16	0.00	0.16	0.00	
3	0.00	0.00	0.00	0.00	0.00	0.05	0.20	0.00	0.34	0.00	0.00	0.00	
4	0.00	1.16	0.00	0.31	0.00	0.48	0.00	0.00	0.00	0.00	0.32	0.00	
5	0.00	0.00	0.62	0.00	0.23	0.01	0.00	0.00	0.00	0.00	0.19	0.00	
6	0.00	0.04	0.40	0.05	0.02	0.00	0.00	0.00	0.80	0.00	0.53	0.00	
7	0.00	2.32	0.00	2.47	0.00	0.00	1.20	0.00	0.01	0.00	0.20	0.53	
8	0.46	0.00	0.00	0.02	0.00	0.00	0.00	0.00	1.53	0.00	0.63	1.93	
9	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.22	0.00	0.32	1.13	
10	0.05	0.75	0.00	0.00	0.00	0.00	0.02	0.53	0.03	0.44	0.07	0.00	
11	0.15	0.74	2.34	0.00	0.00	0.04	0.00	0.00	0.01	0.01	0.00	0.00	
12	1.16	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	1.22	0.00	
13	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.54	0.01	
14	0.00	0.05	0.00	1.97	0.00	0.45	0.00	0.00	0.00	0.05	0.00	0.60	
15	0.00	0.23	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.83	
16	0.00	0.00	0.12	0.00	0.00	0.00	0.36	0.00	0.00	0.05	0.00	0.01	
17	0.00	0.05	0.03	0.00	0.20	0.00	0.15	0.00	0.00	0.93	0.00	0.00	
18	0.00	0.31	0.02	0.00	0.59	0.00	0.04	0.82	0.00	0.01	0.00	0.00	
19	0.00	0.01	0.01	0.00	0.00	0.06	0.03	2.97	0.00	0.00	0.04	0.00	
20	0.00	0.00	0.00	0.00	0.00	0.46	0.41	2.66	0.00	0.14	0.10	0.21	
21	0.00	0.00	0.00	0.00	0.02	1.01	0.06	1.05	0.00	0.00	0.00	0.12	
22	0.56	6.70	0.00	0.45	1.34	0.00	0.00	0.00	0.69	0.00	0.00	0.00	
23	0.00	0.05	0.00	0.05	0.00	0.34	0.00	0.00	0.83	0.00	0.00	0.00	
24	0.00	0.05	0.00	0.06	0.00	0.00	0.00	0.00	1.33	0.00	0.44	0.00	
25	0.00	1.01	0.01	0.00	0.00	0.01	0.00	0.00	0.03	0.16	0.00	0.00	
26	0.01	0.93	0.00	0.42	0.12	0.00	0.00	0.00	0.91	1.08	0.01	0.01	
27	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	
28	0.57	0.60	0.30	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	1.75	
29	0.00		2.77	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00	0.00	
30	0.00		0.11	0.00	0.00	0.00	0.28	0.02	0.00	0.00	0.00	0.00	
31	0.00		0.00		0.00		0.04	0.47		0.00		3.04	
TOTAL	3.12	15.00	7.88	5.88	2.52	3.49	2.83	9.62	7.02	2.90	7.38	10.31	77.95
*Normal	4.92	4.81	4.54	4.81	4.80	3.69	3.65	2.49	3.72	4.16	5.01	5.88	52.48
Difference	- 1.80	10.19	3.34	1.07	-2.28	-0.20	- 0.82	7.13	3.30	- 2.06	2.37	4.43	25.47
Events	10	16	13	10	7	12	12	10	16	10	15	13	144
> 1"	1	4	2	2	1	1	1	3	2	1	2	4	24

EXPERIMENT NO.:	17-SB34	**CROP:**	Soybean	**VARIETY:**	Credenz 4748 LL	**YEAR:**	2017
EXPERIMENT TITLE:	Evaluation of Soybean Production Systems - Stepwise Additions and Deletions (SR vs TR, Population, Fungicides, and Fertility) - Additions						
SOIL TYPE:	Bosket vf sl/Dundee sicl			**CLASS:**	Mollic Hapludalfs/Typic Endoaqualfs		
LOCATION:	Delta Research & Extension Center			**FIELD:**	Field 2 A (South Side - West End)		

	2	**13**	**17**	**9**	**5**	**10**	**11**	**18**	**6**	**3**	**20**	**15**	**19**	**4**	**8**	**12**	**7**	**16**	**1**	**14**	
B	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	B
	5	**15**	**19**	**6**	**4**	**9**	**13**	**16**	**10**	**1**	**17**	**11**	**18**	**3**	**7**	**14**	**8**	**20**	**2**	**12**	
B	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	B
	3	**11**	**18**	**9**	**5**	**8**	**12**	**20**	**7**	**2**	**19**	**14**	**16**	**1**	**10**	**13**	**6**	**17**	**4**	**15**	
B	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	B
	1	**12**	**16**	**8**	**3**	**7**	**14**	**19**	**9**	**4**	**17**	**13**	**20**	**2**	**6**	**15**	**10**	**18**	**5**	**11**	
B	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	B

Trt No	Rows X Seed Rate	Fungi	Desic	Fert P-K	Fert N-S
1	SR-L				
2	SR-L	Y			
3	SR-L	Y	Y		
4	SR-L	Y	Y	Y	
5	SR-L	Y	Y	Y	Y
6	SR-H				
7	SR-H	Y			
8	SR-H	Y	Y		
9	SR-H	Y	Y	Y	
10	SR-H	Y	Y	Y	Y
11	TR-L				
12	TR-L	Y			
13	TR-L	Y	Y		
14	TR-L	Y	Y	Y	
15	TR-L	Y	Y	Y	Y
16	TR-H				
17	TR-H	Y			
18	TR-H	Y	Y		
19	TR-H	Y	Y	Y	
20	TR-H	Y	Y	Y	Y

SR-L = Single-row @104,544 SR-H = Single-row @ 156,816

TR-L = Twin-row @ 104,544 TR-H + Twin-row @ 156,816

Fertilizer P and K: 100 lb P_2O_5/acre and 100 lb K_2O/acre

Fertilizer N and S: Ammonium sulfate @ 100 lb/acre (21-0-0-23)

Nitrogen Application Information:

1 Fertilizer N: _____
2 Fertilizer P: _____
3 Fertilizer K: _____
3 Fertilizer S: _____

Seeding Date and Rate:

1 Seeding Date: _____
2 Seeding Rate: _____
3 Emergence Date: _____
4 Population: _____

Irrigation Information:

1	Date:		Amount:	
2	Date:		Amount:	
3	Date:		Amount:	
4	Date:		Amount:	
5	Date:		Amount:	

Harvest Information:

1 Area: _____
2 Date: _____

Protocol Treatments:

1 Fungicide (R3): _____
2 Desiccant (Pre-H): _____
3 Fertilizer P and K: _____
4 Fertilizer N and S: _____

100 ft plots with 15 ft alleys (Four [4] Replications)

Fungicide: Quadris Top SBX @ 7.5 oz/acre

Desiccant: Gramoxone @ 16 oz/acre

EXPERIMENT NO.:	17-SB35	**CROP:**	Soybean	**VARIETY:**	Credenz 4748 LL	**YEAR:**	2017
EXPERIMENT TITLE:	Evaluation of Soybean Production Systems - Stepwise Additions and Deletions (SR vs TR, Population, Fungicides, and Fertility) - Deletions						
SOIL TYPE:	Bosket vf sl/Dundee sicl			**CLASS:**	Mollic Hapludalfs/Typic Endoaqualfs		
LOCATION:	Delta Research & Extension Center			**FIELD:**	Field 2 A (South Side - East End)		

	2	**13**	**17**	**9**	**5**	**10**	**11**	**18**	**6**	**3**	**20**	**15**	**19**	**4**	**8**	**12**	**7**	**16**	**1**	**14**	
B	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	B
	5	**15**	**19**	**6**	**4**	**9**	**13**	**16**	**10**	**1**	**17**	**11**	**18**	**3**	**7**	**14**	**8**	**20**	**2**	**12**	
B	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	B
	3	**11**	**18**	**9**	**5**	**8**	**12**	**20**	**7**	**2**	**19**	**14**	**16**	**1**	**10**	**13**	**6**	**17**	**4**	**15**	
B	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	B
	1	**12**	**16**	**8**	**3**	**7**	**14**	**19**	**9**	**4**	**17**	**13**	**20**	**2**	**6**	**15**	**10**	**18**	**5**	**11**	
B	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	B

Trt No	Rows X Seed Rate	Fungi	Desic	Fert P-K	Fert N-S
1	SR-L	Y	Y	Y	Y
2	SR-L	Y	Y	Y	
3	SR-L	Y	Y		
4	SR-L	Y			
5	SR-L				
6	SR-H	Y	Y	Y	Y
7	SR-H	Y	Y	Y	
8	SR-H	Y	Y		
9	SR-H	Y			
10	SR-H				
11	TR-L	Y	Y	Y	Y
12	TR-L	Y	Y	Y	
13	TR-L	Y	Y		
14	TR-L	Y			
15	TR-L				
16	TR-H	Y	Y	Y	Y
17	TR-H	Y	Y	Y	
18	TR-H	Y	Y		
19	TR-H	Y			
20	TR-H				

SR-L = Single-row @104,544 SR-H = Single-row @ 156,816

TR-L = Twin-row @ 104,544 TR-H + Twin-row @ 156,816

Fertilizer P and K: 100 lb P_2O_5/acre and 100 lb K_2O/acre

Fertilizer N and S: Ammonium sulfate @ 100 lb/acre (21-0-0-23)

Nitrogen Application Information:

1 Fertilizer N:
2 Fertilizer P:
3 Fertilizer K:
3 Fertilizer S:

Seeding Date and Rate:

1 Seeding Date:
2 Seeding Rate:
3 Emergence Date:
4 Population:

Irrigation Information:

1	Date:		Amount:	
2	Date:		Amount:	
3	Date:		Amount:	
4	Date:		Amount:	
5	Date:		Amount:	

Harvest Information:

1 Area:
2 Date:

Protocol Treatments:

1 Fungicide (R3):
2 Desiccant (Pre-H):
3 Fertilizer P and K:
4 Fertilizer N and S:

100 ft plots with 15 ft alleys (Four [4] Replications)

Fungicide: Quadris Top SBX @ 7.5 oz/acre

Desiccant: Gramoxone @ 16 oz/acre

Table 2. Summary of soybean yield, bushel test weight and Seed Index for single-row and twin-row production at different seeding rates. Multiple input - Additions (18-SB34) Ebelhar and Turner, Delta Research and Extension Center.

Trt.	Treatments Fungi-Desic-P/K-NS	Grain Yield @13% (bu/acre)	Bushel Test Wt. (lb/bu)	Seed Index (g/100 seed)	
Single-Row - 8 seed/ft					
1	Untreated	50.6	52.17	14.1195	d-g
2	Fungicide	54.2	52.82	14.5579	a-f
3	Fungicide + Desiccant	53.5	51.77	14.5671	a-f
4	Fungi + Desicc + P-K	54.7	53.72	14.6072	a-e
5	Fungi + Desicc + P-K + N-S	49.7	51.53	14.4061	b-g
Single-Row - 12 seed/ft					
6	Untreated	50.7	51.93	13.8219	ghi
7	Fungicide	56.4	52.62	14.8579	abc
8	Fungicide + Desiccant	52.0	51.93	14.7609	a-d
9	Fungi + Desicc + P-K	52.1	52.79	15.1445	a
10	Fungi + Desicc + P-K + N-S	54.4	52.02	14.9181	ab
Twin-row - 8 seed/ft					
11	Untreated	50.1	51.99	13.4160	hi
12	Fungicide	53.2	52.58	13.9208	fgh
13	Fungicide + Desiccant	54.0	52.43	13.8718	ghi
14	Fungi + Desicc + P-K	54.8	53.81	13.7553	ghi
15	Fungi + Desicc + P-K + N-S	53.6	52.96	14.0038	e-h
Twin-Row - 12 seed/ft					
16	Untreated	51.3	51.94	13.2466	i
17	Fungicide	55.7	52.55	14.7647	a-d
18	Fungicide + Desiccant	55.8	53.39	14.5626	a-f
19	Fungi + Desicc + P-K	53.5	55.51	14.0210	e-h
20	Fungi + Desicc + P-K + N-S	52.6	52.75	14.2268	c-g
LSD (0.05)		5.1	2.28	0.6651	
Prob. > F		0.2950	0.8798	<0.0001	

Means across four (4) replications (n=4). Means followed by the same letter are not significantly different at the 5% as determined by Fisher's Protected Least Significant Difference. No letters are used where the Prob. > F is not significant.

Table 3. Summary of Main Effects for soybean yield, bushel test weight and Seed Index for single-row and twin-row production at different seeding rates. Multiple input - Additions (18-SB34). Ebelhar and Turner, Delta Research and Extension Center.

Trt.	Treatments Fungi-Desic-P/K-NS	Grain Yield @13% (bu/acre)	Bushel Test Wt. (lb/bu)	Seed Index (g/100 seed)
Whole Plot - Plant Pattern X Seeding				
	SR-8	52.6 [1/]	52.40 [1/]	14.4516 b [1/]
	SR-12	53.1	52.26	14.7007 a
	TR-8	53.1	52.75	13.7935 d
	TR-12	53.8	52.63	14.1643 c
LSD (0.05)		1.1	0.54	0.2333
Prob. > F		0.1810 ns	0.2300 ns	<0.0001
C. V. (%)		7.25	3.28	3.44
Subplot Treatments				
	Untreated	50.1 b [2/]	52.01 [2/]	13.6510 b [2/]
	Fungicide	54.9 a	52.64	14.5253 a
	Fungicide + Desiccant	53.8 a	52.38	14.4406 a
	Fungi + Desicc + P-K	53.8 a	53.21	14.3820 a
	Fungi + Desicc + P-K + N-S	52.7 ab	52.31	14.3881 a
LSD (0.05)		2.7	1.22	0.3498
Prob. > F		0.0356	0.3678 ns	<0.0001
C. V. (%)		7.25	3.28	3.45
Whole Plot X Subplot Interaction		0.8147	0.9571 ns	0.3944 ns

[1/] Means across subplot treatments and replications (n=20). Means followed by the same letter are not significantly different at the 5% as determined by Fisher's Protected Least Significant Difference. No letters are used where the Prob. > F is not significant.

[2/] Means across whole plot treatments and replications (n=16). Means followed by the same letter are not significantly different at the 5% as determined by Fisher's Protected Least Significant Difference. No letters are used where the Prob. > F is not significant.

Table 4. Summary of soybean yield, bushel test weight and Seed Index for single-row and twin-row production at different seeding rates. Multiple input - Deletions (18-SB35) Ebelhar and Turner, Delta Research and Extension Center.

Trt.	Treatments Fungi-Desic-P/K-NS	Grain Yield @13% (bu/acre)	Bushel Test Wt. (lb/bu)	Seed Index (g/100 seed)	
Single-Row - 8 seed/ft					
1	Fungi + Desicc + P-K + N-S	51.3	52.95	13.8028	a-e
2	Fungi + Desicc + P-K	50.3	53.74	13.5712	b-e
3	Fungicide + Desiccant	53.2	53.19	14.1692	abc
4	Fungicide	55.0	54.26	14.0178	a-d
5	Untreated	52.0	52.48	13.2514	e
Single-Row - 12 seed/ft					
6	Fungi + Desicc + P-K + N-S	53.2	53.84	14.2965	ab
7	Fungi + Desicc + P-K	54.9	53.51	14.0556	a-d
8	Fungicide + Desiccant	55.9	54.32	14.2795	ab
9	Fungicide	54.1	53.00	14.3440	a
10	Untreated	54.7	53.51	13.3519	de
Twin-row - 8 seed/ft					
11	Fungi + Desicc + P-K + N-S	52.1	53.66	13.6338	a-e
12	Fungi + Desicc + P-K	53.9	53.78	13.5927	a-e
13	Fungicide + Desiccant	53.7	54.20	13.5939	a-e
14	Fungicide	56.8	53.42	13.6126	a-e
15	Untreated	53.2	54.49	13.2359	e
Twin-Row - 12 seed/ft					
16	Fungi + Desicc + P-K + N-S	52.2	53.53	13.3805	de
17	Fungi + Desicc + P-K	51.9	53.86	13.5164	cde
18	Fungicide + Desiccant	58.1	54.29	13.6982	a-e
19	Fungicide	55.0	52.75	13.5155	cde
20	Untreated	55.4	53.71	13.4405	cde
LSD (0.05)		4.7	1.55	0.7555	
Prob. > F		0.1795	ns 0.4701	ns 0.0515	

Means across four (4) replications (n=4). Means followed by the same letter are not significantly different at the 5% as determined by Fisher's Protected Least Significant Difference. No letters are used where the Prob. > F is not significant.

Table 5: Summary of Main Effects for soybean yield, bushel test weight and Seed Index for single-row and twin-row production at different seeding rates. Multiple input - Deletions (18-SB35). Ebelhar and Turner, Delta Research and Extension Center.

Trt.	Treatments Fungi-Desic-P/K-NS	Grain Yield @13% (bu/acre)	Bushel Test Wt. (lb/bu)	Seed Index (g/100 seed)
Whole Plot - Plant Pattern X Seeding				
	SR-8	52.3 b [1/]	53.32 b [1/]	13.7625 b [1/]
	SR-12	54.5 a	53.64 ab	14.0655 a
	TR-8	54.0 ab	53.91 a	13.5338 bc
	TR-12	54.2 a	53.63 ab	13.5102 c
LSD (0.05)		1.6	0.35	0.2499
Prob. > F		0.0403	0.0279	0.0024
C. V. (%)		6.50	2.19	4.09
Subplot Treatments				
	Fungi + Desicc + P-K + N-S	52.2 b [2/]	53.50 [2/]	13.7784 a [2/]
	Fungi + Desicc + P-K	52.8 ab	53.72	13.6840 ab
	Fungicide + Desiccant	55.2 a	54.00	13.9352 a
	Fungicide	55.2 a	53.36	13.8725 a
	Untreated	53.8 ab	53.55	13.3200 b
LSD (0.05)		2.5	0.84	0.3991
Prob. > F		0.0507	0.5945 ns	0.0284
C. V (%)		6.50	2.19	4.09
Whole Plot X Subplot Interaction		0.7629 ns	0.5165 ns	0.9203 ns

[1/] Means across subplot treatments and replications (n=20). Means followed by the same letter are not significantly different at the 5% as determined by Fisher's Protected Least Significant Difference. No letters are used where the Prob. > F is not significant.

[2/] Means across whole plot treatments and replications (n=16). Means followed by the same letter are not significantly different at the 5% as determined by Fisher's Protected Least Significant Difference. No letters are used where the Prob. > F is not significant.

Table 6: Summary of soybean yield, bushel test weight and Seed Index for single-row and twin-row production at different seeding rates - Early Planting. Main Effects and Interaction Effects. Ebelhar and Turner, Delta Research and Extension Center (2018 Early Planting).

Trt.	Treatments		Grain Yield @13% (bu/acre)	Bushel Test Wt. (lb/bu)	Seed Index (g/100 seed)
	Seed/ft	Seed/acre			
	SR-6	78,408	50.1 [1/]	54.73 [1/]	13.7054 [1/]
	SR-8	104,554	49.4	53.37	13.7022
	SR-10	130,680	49.5	54.77	13.3312
	SR-12	156,816	49.6	54.72	13.6464
	TR-6	78,408	47.2	54.40	13.1969
	TR-8	104,554	48.3	54.14	13.7647
	TR-10	130,680	48.6	54.59	13.2821
	TR-12	156,816	52.0	53.61	13.5607
Overall Mean			49.3	54.29	13.5237
LSD (0.05)			7.6	2.35	0.4774
Prob. > F			0.9581 ns	0.8822 ns	0.1240 ns
C. V. (%)			15.29	4.31	3.51
Planting Pattern (Main)					
	Single-row		49.6 [2/]	54.40 [2/]	13.5963 [2/]
	Twin-row		49.0	54.19	13.4511
	LSD (0.05)		3.8	1.18	0.2387
	Prob > F		0.7371 ns	0.7181 ns	0.2274 ns
Seeding Rate (Main)					
	6 seed/ft		48.6 [3/]	54.57 [3/]	13.4511 [3/]
	8 seed/ft		48.8	53.76	13.7335
	10 seed/ft		49.1	54.68	13.3066
	12 seed/ft		50.8	54.16	13.6036
	LSD (0.05)		5.4	1.66	0.3376
	Prob > F		0.8407 ns	0.6755 ns	0.0766 ns
	Planting Pattern X Seed rate		0.7957 ns	0.7294 ns	0.3543 ns

[1/] Means across replications (n=8). Means followed by the same letter are not significantly different at the 5% as determined by Fisher's Protected Least Significant Difference. No letters are used where the Prob. > F is not significant.

[2/] Means across 3 seeding rates and 8 replications (n=24). Means followed by the same letter are not significantly different at 5% as determined by Fisher's Protected LSD. No letters are used where F is not significant.

[3/] Means across 2 planting patterns and 8 replications (n=16). Means followed by the same letter are not significantly different at 5% as determined by Fisher's Protected LSD. No letters are used where F is not significant.

Table 7: Summary of harvest moisture, main stem and branch stem nodes, and plant height for single-row and twin-row production at different seeding rates (Early Planting). Main Effects and Interaction Effects. Ebelhar and Turner, DREC (2018 Early Planting).

Treatments		Harvest Moisture (%)	Main Stem (Nodes)	Branch (Nodes)	Plant Height (In)
Seed/ft	Seed/Acre				
SR-6	78,408	10.8 [1/]	15.0 [1/]	10.6 b [1/]	35.9 [1/]
SR-8	104,554	11.0	16.2	9.9 b	35.7
SR-10	130,680	11.0	14.6	3.6 c	35.6
SR-12	156,816	11.1	15.1	7.4 bc	36.2
SR-6	78,408	11.0	15.3	17.1 a	36.4
TR-8	104,554	10.9	14.9	12.2 ab	34.5
TR-10	130,680	10.9	15.0	7.3 bc	35.0
TR-12	156,816	10.8	15.5	11.3 b	35.1
Overall Mean		10.9	15.2	9.9	35.6
LSD (0.05)		0.3	1.1	5.3	1.9
Prob. > F		0.5997 ns	0.1740 ns	0.0004	0.5030 ns
C. V. (%)		2.41	7.15	52.60	5.32
Planting Pattern (Main)					
Single-row		11.0 [2/]	15.2 [2/]	7.9 b [2/]	35.8 [2/]
Twin-row		10.9	15.2	12.0 a	35.3
LSD (0.05)		0.1	0.5	2.6	1.0
Prob > F		0.3011 ns	0.8998 ns	0.0028	0.2351 ns
Seeding Rate (Main)					
6 seed/ft		10.9 [3/]	15.2 [3/]	13.9 a [3/]	36.2 [3/]
8 seed/ft		10.9	15.5	11.0 ab	35.1
10 seed/ft		10.9	14.8	5.4 c	35.3
12/seed/ft		11.0	15.3	9.4 b	35.6
LSD (0.05)		0.2	0.8	3.7	1.3
Prob > F		0.9050 ns	0.3102 ns	0.0004	0.4041 ns
PP X SR Interaction		0.2880 ns	0.0812 ns	0.7223 ns	0.5803 ns

[1/] Means across replications (n=8). Means followed by the same letter are not significantly different at the 5% as determined by Fisher's Protected Least Significant Difference. No letters are used where the Prob. > F is not significant.

[2/] Means across 3 seeding rates and 8 replications (n=24). Means followed by the same letter are not significantly different at 5% as determined by Fisher's Protected LSD. No letters are used where F is not significant.

[3/] Means across 2 planting patterns and 8 replications (n=16). Means followed by the same letter are not significantly different at 5% as determined by Fisher's Protected LSD. No letters are used where F is not significant.

Table 8: Summary of soybean yield, bushel test weight and Seed Index for single-row and twin-row production at different seeding rates - Late Planting. Main Effects and Interaction Effects. Ebelhar and Turner, Delta Research and Extension Center (2018 Late Planting).

Trt.	Treatments		Grain Yield @13% (bu/acre)	Bushel Test Wt. (lb/bu)	Seed Index (g/100 seed)
	Seed/ft	Seed/acre			
	SR-6	78,408	34.3 a-d [1/]	55.27 c [1/]	15.2995 a [1/]
	SR-8	104,554	25.9 d	55.04 c	14.8833 ab
	SR-10	130,680	28.7 cd	56.20 abc	14.9044 ab
	SR-12	156,816	38.0 abc	55.91 bc	14.8483 ab
	TR-6	78,408	30.5 bcd	57.27 ab	14.9125 ab
	TR-8	104,554	25.7 d	57.67 a	14.5236 b
	TR-10	130,680	44.2 a	57.54 a	14.2903 b
	TR-12	156,816	39.5 ab	57.30 ab	14.2798 b
Overall Mean			33.4	56.52	14.7427
LSD (0.05)			10.3	1.61	0.6540
Prob. > F			0.0040	0.0042	0.0392
C. V. (%)			30.65	2.83	4.41
Planting Pattern (Main)					
	Single-row		31.7 [2/]	55.60 b [2/]	14.9839 a [2/]
	Twin-row		35.0	57.44 a	14.5015 b
	LSD (0.05)		5.1	0.80	0.3270
	Prob > F		0.2114 ns	<0.0001	0.0047
Seeding Rate (Main)					
	6 seed/ft		32.4 ab [3/]	56.27 [3/]	15.1060 [3/]
	8 seed/ft		25.8 b	56.35	14.7034
	10 seed/ft		36.4 a	56.87	14.5973
	12 seed/ft		38.7 a	56.60	14.5640
	LSD (0.05)		7.3	1.14	0.4624
	Prob > F		0.0046 ns	0.7071 ns	0.0839 ns
	Planting Pattern X Seed rate		0.0545 ns (?)	0.6379 ns	0.9267 ns

[1/] Means across replications (n=8). Means followed by the same letter are not significantly different at the 5% as determined by Fisher's Protected Least Significant Difference. No letters are used where the Prob. > F is not significant.

[2/] Means across 4 seeding rates and 8 replications (n=32). Means followed by the same letter are not significantly different at 5% as determined by Fisher's Protected LSD. No letters are used where F is not significant.

[3/] Means across 2 planting patterns and 8 replications (n=16). Means followed by the same letter are not significantly different at 5% as determined by Fisher's Protected LSD. No letters are used where F is not significant.

Table 9: Summary of harvest moisture, stand counts, and plant height for single-row and twin-row production at different seeding rates (Early Planting). Main Effects and Interaction Effects. Ebelhar and Turner, Delta Research and Extension Center (2018 Early Planting).

Treatments		Harvest Moisture (%)	Main Stem Nodes	Branch Nodes	Plant Height (In)
Seed/ft	Seed/Ac				
SR-6	78,408	11.8 a-d [1/]	15.8 [1/]	20.9 [1/]	31.7 [1/]
SR-8	104,554	12.6 a	15.7	21.8	31.9
SR-10	130,680	12.0 abc	15.3	21.9	31.9
SR-12	156,816	12.2 ab	15.7	24.5	31.1
SR-6	78,408	11.2 b-e	15.9	23.0	31.6
TR-8	104,554	10.8 e	16.6	18.4	34.0
TR-10	130,680	10.9 de	16.2	20.2	33.4
TR-12	156,816	11.2 cde	16.1	16.4	34.4
Overall Mean		11.6	15.9	20.9	32.5
LSD (0.05)		1.0	1.6	8.0	2.9
Prob. > F		0.0048	0.8594 ns	0.5696 ns	0.1960 ns
C. V. (%)		8.88	9.87	38.01	8.77
Planting Pattern (Main)					
Single-row		12.2 a [2/]	15.6 [2/]	22.3 [2/]	31.7 a [2/]
Twin-row		11.0 b	16.2	19.5	33.4 b
LSD (0.05)		0.5	0.8	4.0	1.4
Prob > F		<0.0001	0.1493 ns	0.1711 ns	0.0210
Seeding Rate (Main)					
6 seed/ft		11.5 [3/]	15.9 [3/]	22.0 [3/]	31.7 [3/]
8 seed/ft		11.7	16.1	20.1	33.0
10 seed/ft		11.4	15.7	21.1	32.7
12/seed/ft		11.7	16.0	20.5	32.7
LSD (0.05)		0.7	1.1	5.6	2.0
Prob > F		0.8535 ns	0.9085 ns	0.9162 ns	0.5859 ns
PP X SR Interaction		0.4495 ns	0.9139 ns	0.3511 ns	0.4442 ns

[1/] Means across replications (n=8). Means followed by the same letter are not significantly different at the 5% as determined by Fisher's Protected Least Significant Difference. No letters are used where the Prob. > F is not significant.

[2/] Means across 3 seeding rates and 8 replications (n=24). Means followed by the same letter are not significantly different at 5% as determined by Fisher's Protected LSD. No letters are used where F is not significant.

[3/] Means across 2 planting patterns and 8 replications (n=16). Means followed by the same letter are not significantly different at 5% as determined by Fisher's Protected LSD. No letters are used where F is not significant.