Development of Fertilization Practices for Sustaining Mississippi Soybean Production
MSPB Project No. 22-2019

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Background and Objectives

Limited recent research exists in Mississippi regarding correlation of soil test indices to plant nutrient concentration and/or yield. Mississippi currently employs the Lancaster method to determine soil nutrient availability. Limited research investigating Lancaster extracted P and K correlation to soybean tissue concentration and yield suggests that differences may exist between Lancaster and Mehlich-3 extractable soil test P and K and soybean yield. Current data suggests that establishment of differing soil test critical levels among the two extraction procedures may be warranted, especially for P. Future research will maintain the current database and add new data points to allow for a more robust model to identify what soil test level soybean will respond positively to fertilization.

Secondly as Mississippi producers have shifted to a more grain-based system, S deficient soybean fields have routinely been observed in Mississippi over the last several years. Currently, most producers apply sulfur to corn and rice, but very few apply sulfur to soybean. Research is needed to determine the appropriate sulfur source, application rate and timing for fields that require sulfur fertilization in Mississippi to produce maximal yield. Currently very little information exists on crop response to soil test based sulfur recommendations. Mississippi State University currently employs a differing soil test S index than most private and public laboratories in the Mid-south region of the U.S. Therefore correlation and calibration attempts for sulfur are required, and research will take a similar path as with recent and continuing work with P and K.

In Recent years, producer concern has risen over differences in soil test results when crop rotation has changed. In Mississippi we are blessed to have soils that support many cropping systems, however the blessing also allows us to alter the crop mix as commodity price changes. Soybean is the backbone of most rotational cropping systems in Mississippi. Little recent research has described differences in soil test variability when soybeans rotation partners shift. Numerous research has described the positive benefit of rotating soybean with corn on both crops potential in Mississippi, but limited data is available describing the impact of rotating soybean and rice on soil test properties.

OBJECTIVE(S):

Objective 1. Evaluate crop response to P and K fertilization and continue to build the MS soil test responsiveness database used to update soil test recommendations for both Lancaster and Mehlich-3 extractants.

Objective 2. Determine the appropriate S source, application rate and time for Mississippi Soybean production. Initiate database to generate soil test recommendations for S responsiveness used to develop Mehlich-3 recommendations and update current Modified combustion recommendations.

Objective 3. Determine the influence of in-season potash application on soybean yield and quality.
3A. Evaluate the influence of in season potash application timing (reproductive stages) on soybean yield and quality
3B. Determine if in season potash application aids plant recovery and improves soybean quality after off target herbicide injury occurs.

Report of Progress/Activity

2019

Objective 1.

During 2019, research was established on numerous sites on grower farms and at on station research location, every year we lose on farm sites and 2019 was no different. We concluded the season with two harvestable sites for P, two harvestable sites for K research, and three harvestable sites for sulfur research. Overall, in all correlation calibration trials yields were down from previous years of testing with soybean yields generally ranging somewhere between 50 to 65 bu/ac. The extended period of rainfall during the harvest season led to some yield loss from beans shattering before it was dry enough to get the combines back in the field, especially on the clay soils and may explain the lower soybean yields observed as well as the lack of response on soil where soil test would have been marginal. We added a K source Trial in 2019 to evaluate differences among currently available products on the market and one experimental.

For the P research we did not observe a yield response on either trial that was harvestable. Both sites had a soil test value above 30 ppm, which is our current critical level. These data will be added to the data base to better reflect when and where MS soils respond to phosphorus application. Yield data is presented in figure 1.

For the second year in a row we did not observe a yield response at the two sites that were harvestable for K correlation calibration trials. We had one site with a soil test value we expected a response and the other was near the critical level. On the site with the expected response, the planting date was much later than usual and could have been the reason for the lack of response. Yield data is presented in figure 2.

During 2019 we evaluated multiple K products at the same K rate to see if one had an advantage over the standard of MOP. As new products emerge on the market it is important to test them against the commonly used standard. In this trial all MOP products produced yields greater than that of the control and the combination of MOP/KMAG produced the greatest yields above all other treatments. Yield data is presented in figure 3.

Objective 2.

Four trials were established to evaluate soybean response to sulfur rate and/or sulfur product, application time and source. We were fortunate that 3 of the four trials were harvestable. The two trials evaluating sulfur rate did not indicate a response to sulfur fertilization (Fig 4). Similar to last year this was unexpected at the VFSL site as soil test sulfur was within the range that a sulfur recommendation would have been suggested. Yield data for the sulfur correlation calibration trials are presented in table 4.

Trials evaluating sulfur source and application resulted in a positive response above the untreated control. No differences were observed among products or application timings. Last year on sites where responses occurred soil test values were less than 50, which would be considered very low. These first two years of data underscores the importance of reevaluating sulfur recommendations in MS to ensure that we have a firm understanding of when sulfur is required by developing new robust models that develop new critical concentrations for soil test sulfur.

Objective 3.

The new objective (3) began in 2019 was conducted all on station in year one. This was primarily due to it being a grad student project in which we could not afford to lose sites, and a function of the late plating window.

Two trials were established to determine the influence of in-season potash application timing (reproductive growth stages) on soybean yield and quality. The mean soil test results for potassium studies conducted in 2019 are reported in table 1. Site 1 and site 2 were the same potassium rate by potassium timing study with a Asgrow 45X8 soybean planted and replicated at two different locations: a commerce silt loam soil (site 1) and a tunica clay (site 2). Potassium was applied at the R3, R5.5, R6.5, and postharvest application timings at rates of 0, 40, 80, 120 lb K a^{-1}. Results from these trials (table 2 and table 3) indicate that no yield increase occurred when potassium was applied. This was possibly due to the high K soil levels present at both locations. The grain quality data has not yet been assessed due to USDA machine maintenance. We plan to continue both studies in 2020, and add an additional location at Verona.

Two trials were established to determine if in season potash application (reproductive growth stages) aids plant recovery and improves soybean quality after off target herbicide injury. The mean soil test results for potassium studies conducted in 2019 are reported in table 1. Site 3 and site 4 were tunica clay soils. For these studies a Credenz CZ4539 GTLL soybean was planted. Dicamba was applied at simulated drift rates of 0 (0x), 0.03125 (1/512x), and 0.1562 (1/1024x) oz a^{-1} once the soybeans reached the R1 growth stage. Site 3 was a potassium rate by dicamba rate study. Potassium was applied at rates of 0, 80, 120, and 160 lb K a^{-1} at the R2 growth stage. Results from this study (table 4) indicate that no yield increase occurred when potassium was applied during reproductive growth stages. Site 4 was a potassium rate by by potassium timing by dicamba rate study. Potassium was applied at rates of 0 and 80 lb K a^{-1} during reproductive growth (R1, R3, R5.5, and R6.5). Results from this study (table 5) indicate that no yield increase occurred when potassium was applied during reproductive growth stages. All plots received 2 additional non planned synthetic auxin drift events which explains why the non-treated plots yielded the same as the treated plots. The grain quality data has not yet been assessed due to USDA machine maintenance. We plan to continue both studies in 2020.

One trial was established to determine if in season potash application (reproductive growth stages) aids plant yield and improves soybean quality after a desiccant application. The mean soil test results for potassium studies conducted in 2019 are reported in table 1. A Credenz CZ4539 GTLL soybean was planted on a tunica clay soil. Paraquat was applied at rates of 0 (0x) and 16 (1x) oz a^{-1} once the soybeans reached the R6.5 growth stage. Potassium was applied at two rates (0 and 80 lb K a^{-1}) at the R1, R3, R5.5, and R6.5 growth stages. Results from this study (table 6) indicate that no yield increase occurred when potassium was applied during reproductive growth stages. These results are possibly due the occurrence of 2 no planned off target synthetic auxin drift events. The grain quality data has not yet been assessed due to USDA machine maintenance. We plan to continue the desiccant study in 2020.

Graphics/Tables

Table 1. Selected soil property means of five potassium trials conducted at DREC											
				Lancaster extractable nutrients							
Site†	pH	CEC	SOM	P	K	Ca	Mg	Ma	Zn	Mn	S
				--------------------------------lb a^{1}--------------------------------							
1	6.5	9.9	1.5	75.6	372.7	2413.7	445.1	44.4	2.4	81.9	68.7
2	8.2	26.1	2.1	123.2	414.2	8152.7	1412.1	87.9	3.6	161.1	231.5
3	8.0	26.6	1.8	99.4	403.1	7927.9	1583.2	91.9	3.8	129.5	239.7
4	8.1	27.1	1.9	67.4	468.2	8892.2	1659.6	91.1	3.0	134.7	281.9
5	8.1	25.9	2.1	65.8	432.8	8713.2	1510.1	80.0	2.6	133.8	284.5

† Site 1 is the potassium timing and rate test conducted on a silt loam soil; Site 2 is the potassium timing and rate test conducted on a clay soil; Site 3 is the potassium rate test following dicamba exposure; Site 4 is the potassium timing test following dicamba exposure; Site 5 is the potassium rate with desiccant test.

Table 2. Yield response to potassium rate and timing for soybean grown on silt loam soils				
Treatment	K timing	K Rate	Yield	Letter Separation
		-----lb K a^{-1}-----	-----bu a^{-1}-----	
1	R3	40	68.2	A
2	R5.5	40	68.8	A
3	R6.5	40	70.7	A
4	Postharvest	40	71.1	A
5	R3	80	71.8	A
6	R5.5	80	69.8	A
7	R6.5	80	71.0	A
8	Postharvest	80	73.6	A
9	R3	120	68.4	A
10	R5.5	120	61.8	A
11	R6.5	120	67.9	A
12	Postharvest	120	70.3	A
13	Check	0	71.8	A

Table 3. Yield response to potassium rate and timing for soybean grown on clay soils				
Treatment	K timing	K Rate	Yield	Letter Separation
		-----lb K a^{-1}-----	-----bu a^{-1}-----	
1	R3	40	70.7	A
2	R5.5	40	72.1	A
3	R6.5	40	70.7	A
4	Postharvest	40	72.1	A
5	R3	80	74.2	A
6	R5.5	80	69.9	A
7	R6.5	80	70.0	A
8	Postharvest	80	71.8	A
9	R3	120	71.4	A
10	R5.5	120	70.0	A
11	R6.5	120	69.6	A
12	Postharvest	120	73.5	A
13	Check	0	71.8	A

Table 4. Yield response to potassium rate applied at the R2 growth stage following dicamba drift exposure for soybean grown on clay soils				
Treatment	K Rate	Dicamba Rate	Yield	Letter Separation
	-----lb K a^{-1}-----	--oz a^{-1} (rate)--	-----bu a^{-1}-----	
1	0	0 (0x)	44.2	A
2	80	0 (0x)	44.5	A
3	120	0 (0x)	48.2	A
4	160	0 (0x)	46.3	A
5	0	0.03125 (1/512x)	44.5	A
6	80	0.03125 (1/512x)	40.6	A
7	120	0.03125 (1/512x)	41.3	A
8	160	0.03125 (1/512x)	43.1	A
9	0	0.01562 (1/1024x)	43.5	A
10	80	0.01562 (1/1024x)	44.2	A
11	120	0.01562 (1/1024x)	42.0	A
12	160	0.01562 (1/1024x)	41.7	A

Table 5. Yield response to potassium timing following dicamba drift exposure for soybean grown on clay soils					
Treatment	K Rate	K Timing	Dicamba Rate	Yield	Letter Separation

	----lb K a^{-1}----		--oz a^{-1} (rate)--	-----bu a^{-1}-----	
1	0	Na	0 (0x)	58.4	A
2	80	R1	0 (0x)	58.0	A
3	80	R3	0 (0x)	57.7	A
4	80	R5	0 (0x)	58.6	A
5	80	R6.5	0 (0x)	55.4	A
6	0	Na	0.03125 (1/512x)	51.0	A
7	80	R1	0.03125 (1/512x)	52.6	A
8	80	R3	0.03125 (1/512x)	51.2	A
9	80	R5	0.03125 (1/512x)	51.5	A
10	80	R6.5	0.03125 (1/512x)	52.8	A
11	0	Na	0.01562 (1/1024x)	54.4	A
12	80	R1	0.01562 (1/1024x)	52.5	A
13	80	R3	0.01562 (1/1024x)	55.2	A
14	80	R5	0.01562 (1/1024x)	55.8	A
15	80	R6.5	0.01562 (1/1024x)	51.8	A

Table 6. Yield response to potassium timing following dessication for soybean grown on clay soils

Treatment	K Rate	K Timing	Paraquat Rate	Yield	Letter Separation
	----lb K a^{-1}----		--oz a^{-1} (rate)--	-----bu a^{-1}-----	
1	0	Na	0 (0x)	55.9	A
2	80	R1	0 (0x)	58.2	A
3	80	R3	0 (0x)	55.2	A
4	80	R5	0 (0x)	52.8	A
5	80	R6.5	0 (0x)	54.5	A
6	0	Na	16 (1x)	49.5	A
7	80	R1	16 (1x)	51.9	A
8	80	R3	16 (1x)	50.6	A
9	80	R5	16 (1x)	50.0	A
10	80	R6.5	16 (1x)	48.8	A

Figure 1. Soybean yield increase as a function of phosphorus fertilizer rate at all sites managed for correlation calibration trials during 2019.

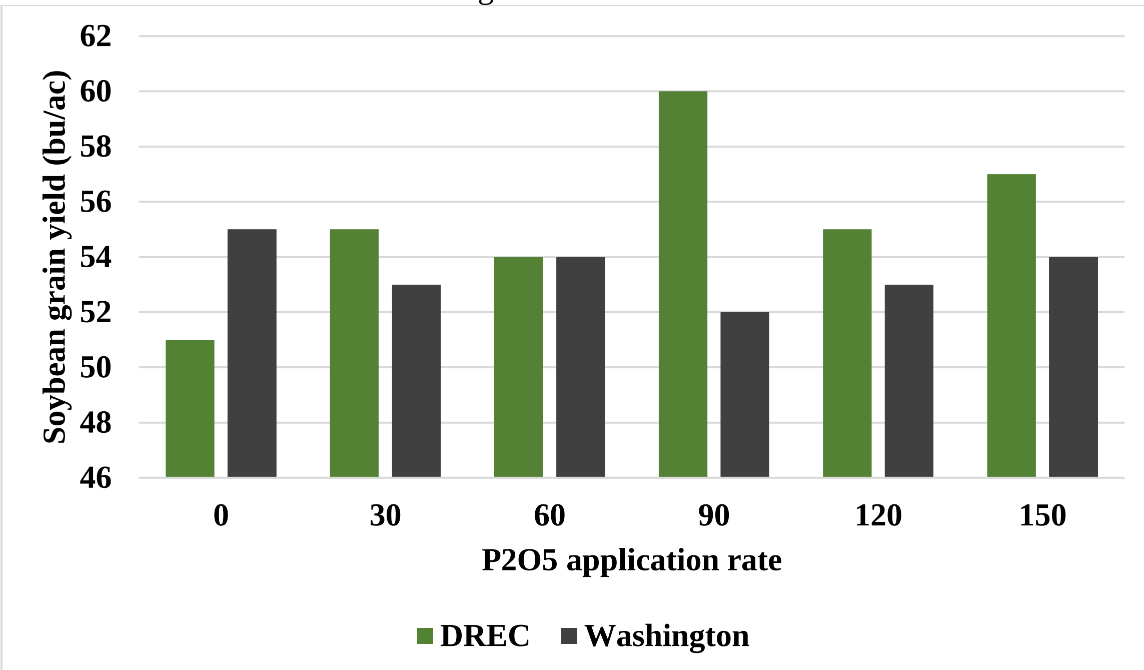

Figure 2. Soybean yield increase as a function of potassium fertilizer rate at all sites managed for correlation calibration trials during 2019.

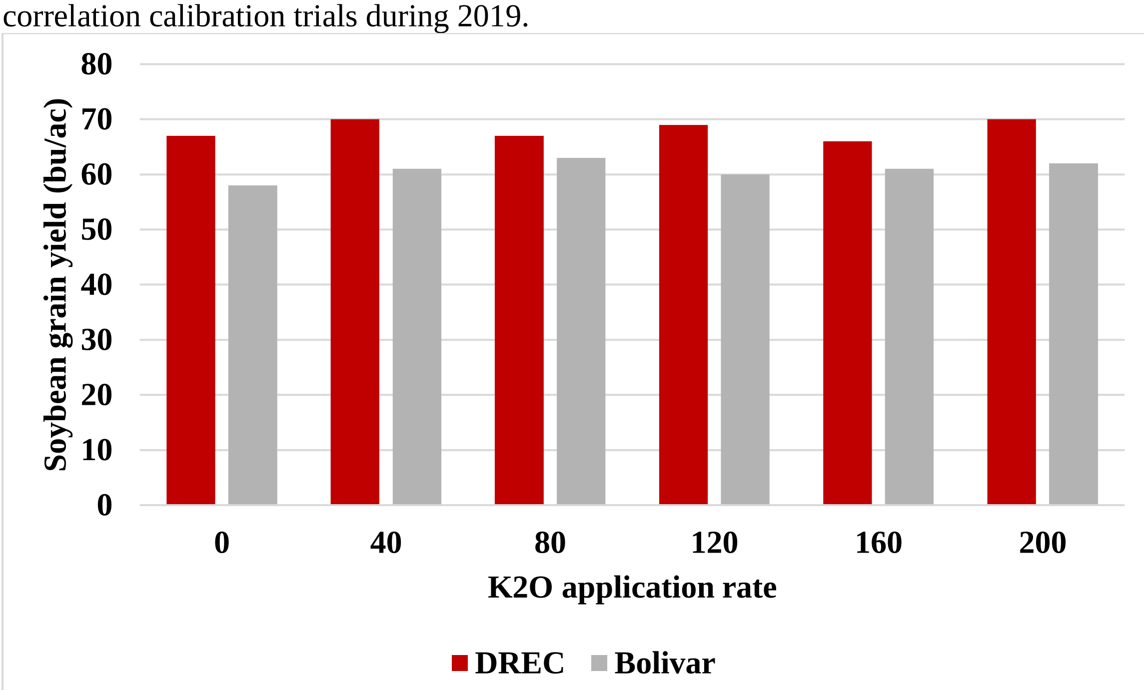

Figure 3. Potassium source trial evaluating multiple K products applied at 60 lb K20/acre for a research site at the Delta Research and Extension Center.

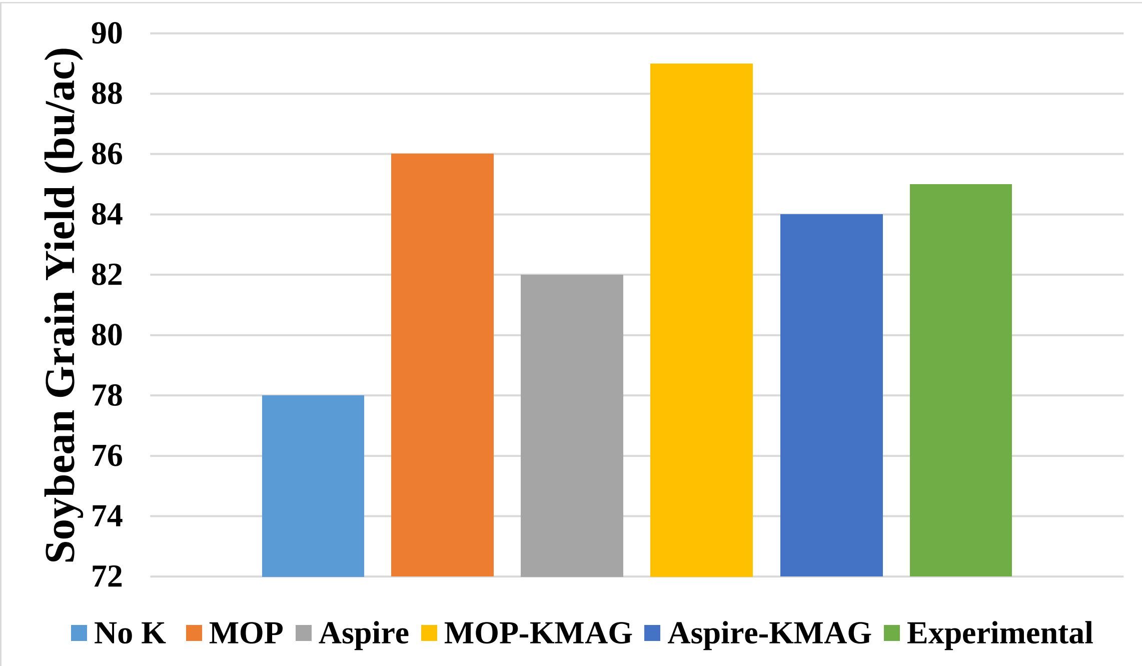

Figure 4. Soybean yield increase as a function of S fertilizer rate at all sites managed for correlation calibration trials during 2019. DREC- VFSL, Bolivar SCL.

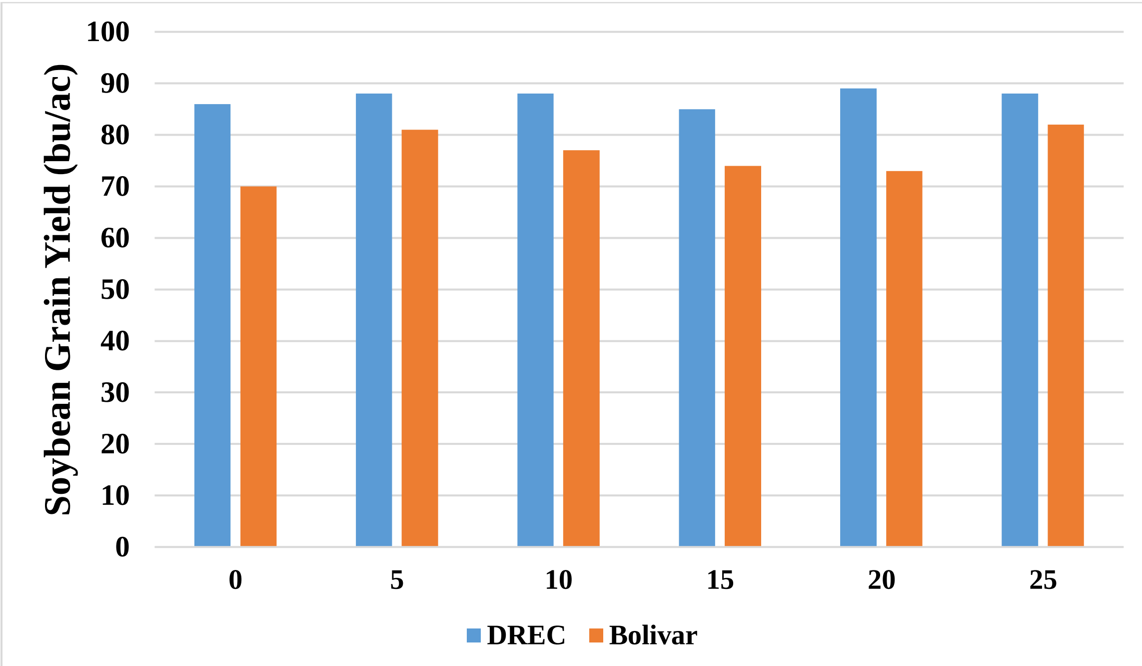

Figure 5. Soybean yield as influenced S fertilizer source and application time at a VFSL soil site at DREC managed for sulfur source response trials during 2019.