Development of Fertilization Practices for Sustaining Mississippi Soybean Production
MSPB Project No. 22-2020

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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

<u>2020</u>

<u>Objective 1.</u>

During 2020, research was established on station research locations. We concluded the season with zero harvestable sites for P, two harvestable sites for K research, and two harvestable sites for sulfur research. Overall, in all correlation calibration trials yields were average to above average from previous years of testing with soybean yields generally ranging somewhere between 60 to 105 bu/ac.

The P research was not harvested due to weather and equipment malfunctions.

For the third 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 K fertilization response. Yield data is presented in figure 1.

As measured in 2019, during 2020 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 and Aspire/KMAG produced the greatest yields above all other treatments. Yield data is presented in figure 2.

<u>Objective 2.</u>

Four trials were established to evaluate soybean response to sulfur rate and/or sulfur product, application time and source. We were fortunate that 2 of the four trials were harvestable. The trial evaluating sulfur rate did not indicate a response to sulfur fertilization (Fig 3). 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.

Trials evaluating sulfur source and application time 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. The first three 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.

This project began in 2019 and was conducted all on station (DREC) in year one. However, for 2020, an additional trial was established in Verona (NMREC).

Three 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 2020 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 at the DREC: a commerce silt loam soil (site 1) and a tunica clay (site 2). Site 3 was the same potassium rate by potassium timing study with a Asgrow 45X8 soybean planted at the NMREC on a Catalpa silty clay loam. 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, table 3, and table 4) indicate that a yield increase occurred when potassium was applied for 1 of the 3 trials. I would like to note that site 2 had stand issues, causing plot yield outliers, but we decided to keep the study. Outliers in site 2 have not been dismissed due to data continuation in 2021, which will explain the large HSD value. The grain quality data has not yet been assessed due to USDA machine maintenance and USDA worker absent due to COVID19. We plan to continue both studies conducted at the DREC in 2021.

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 2020 are reported in table 1. Site 4 and site 5 were tunica clay soils. For these studies a Rev 5190E 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 4 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 5) indicate that no yield increase occurred when potassium was applied during reproductive growth stages. Site 5 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 6) indicate that no yield increase occurred when potassium was applied during reproductive growth stages. All plots received 1 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 not working due to COVID19. We plan to continue both drift studies in 2021.

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 2020 are reported in table 1. A Rev 5190E soybean was planted on a tunica clay soil (site 6). 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 7) indicate that no yield increase occurred when potassium was applied during reproductive growth stages. These results are possibly due the occurrence of 1 off target synthetic auxin drift events. The grain quality data has not yet been assessed due to USDA not working due to COVID19. We plan to continue the desiccant study in 2021.

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	Na	Zn	Mn	S
				--------------------------------lb a^{1}--------------------------------							
1	6.7	9.3	1.0	68.9	336.7	2351.5	417.6	92.1	2.1	85.7	123.9
2	7.8	23.8	1.6	122.8	550.8	6917.5	1315.6	144.0	2.9	105.1	336.3
3	8.1	21.1	2.4	51.2	315.0	50275.2	138.3	32.1	0.7	102.1	1950.6
4	7.8	24.3	2.5	68.3	464.9	8321.1	1108.3	62.4	1.0	73.9	344.8
5	7.7	25.9	1.7	57.5	523.5	8409.9	1433.3	126.7	2.1	83.4	324.9
6	7.7	23.7	1.6	51.3	396.2	7853.9	1167.2	48.3	1.5	79.3	367.3

† Site 1 is the potassium timing and rate test conducted on a silt loam soil at DREC; Site 2 is the potassium timing and rate test conducted on a clay soil at DREC; Site 3 is the potassium timing and rate test conducted on a silty clay loam at NMREC; Site 4 is the potassium rate test following dicamba exposure; Site 5 is the potassium timing test following dicamba exposure; Site 6 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	74.1	ABC
2	R5.5	40	74.2	ABC
3	R6.5	40	78.9	AB
4	Postharvest	40	74.8	ABC
5	R3	80	75.8	ABC
6	R5.5	80	74.9	ABC
7	R6.5	80	73.1	ABC
8	Postharvest	80	80.1	A
9	R3	120	69.8	C
10	R5.5	120	71.8	bc
11	R6.5	120	75.4	ABC
12	Postharvest	120	74.5	ABC
13	Check	0	69.3	C

† Tukey HSD (P=0.10) = 7.68

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	53.2	A
2	R5.5	40	58.5	A
3	R6.5	40	50.7	A
4	Postharvest	40	46.8	A
5	R3	80	44.6	A
6	R5.5	80	49.4	A
7	R6.5	80	48.9	A
8	Postharvest	80	45.0	A
9	R3	120	45.6	A
10	R5.5	120	43.3	A
11	R6.5	120	47.3	A
12	Postharvest	120	34.7	A
13	Check	0	45.4	A

† Tukey HSD (P=0.10) = 25.74

Table 4. Yield response to potassium rate and timing for soybean grown on silty clay loam soils				
Treatment	K timing	K Rate	Yield	Letter Separation
		-----lb K a^{-1}-----	-----bu a^{-1}-----	
1	R3	40	39.6	A
2	R5.5	40	38.8	A
3	R6.5	40	38.5	A
4	Postharvest	40	38.6	A
5	R3	80	37.2	A
6	R5.5	80	36.8	A
7	R6.5	80	37.4	A
8	Postharvest	80	40.2	A
9	R3	120	39.0	A
10	R5.5	120	38.1	A
11	R6.5	120	39.9	A
12	Postharvest	120	38.0	A
13	Check	0	38.6	A

† Tukey HSD (P=0.10) = 3.69

Table 5. 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)	49.8	A
2	80	0 (0x)	47.5	A
3	120	0 (0x)	47.7	A
4	160	0 (0x)	50.5	A
5	0	0.03125 (1/512x)	49.0	A
6	80	0.03125 (1/512x)	45.4	A
7	120	0.03125 (1/512x)	46.0	A
8	160	0.03125 (1/512x)	48.5	A
9	0	0.01562 (1/1024x)	45.5	A
10	80	0.01562 (1/1024x)	46.3	A
11	120	0.01562 (1/1024x)	47.7	A
12	160	0.01562 (1/1024x)	46.7	A

† Tukey HSD (P=0.10) = 6.64

Table 6. 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)	51.9	A
2	80	R1	0 (0x)	54.0	A
3	80	R3	0 (0x)	54.9	A
4	80	R5	0 (0x)	52.8	A
5	80	R6.5	0 (0x)	51.9	A
6	0	Na	0.03125 (1/512x)	53.4	A
7	80	R1	0.03125 (1/512x)	53.6	A
8	80	R3	0.03125 (1/512x)	50.2	A
9	80	R5	0.03125 (1/512x)	52.9	A
10	80	R6.5	0.03125 (1/512x)	51.6	A
11	0	Na	0.01562 (1/1024x)	54.5	A
12	80	R1	0.01562 (1/1024x)	53.0	A
13	80	R3	0.01562 (1/1024x)	53.5	A
14	80	R5	0.01562 (1/1024x)	51.1	A
15	80	R6.5	0.01562 (1/1024x)	50.4	A

† Tukey HSD (P=0.10) = 7.93

Table 7. 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)	48.3	A
2	80	R1	0 (0x)	40.4	A
3	80	R3	0 (0x)	40.5	A
4	80	R5	0 (0x)	44.2	A
5	80	R6.5	0 (0x)	45.6	A
6	0	Na	16 (1x)	42.3	A
7	80	R1	16 (1x)	50.3	A
8	80	R3	16 (1x)	49.8	A
9	80	R5	16 (1x)	38.1	A
10	80	R6.5	16 (1x)	44.3	A

† Tukey HSD (P=0.10) = 15.87

Figure 1. Soybean yield increase as a function of potassium fertilizer rate at all sites managed for correlation calibration trials during 2020.

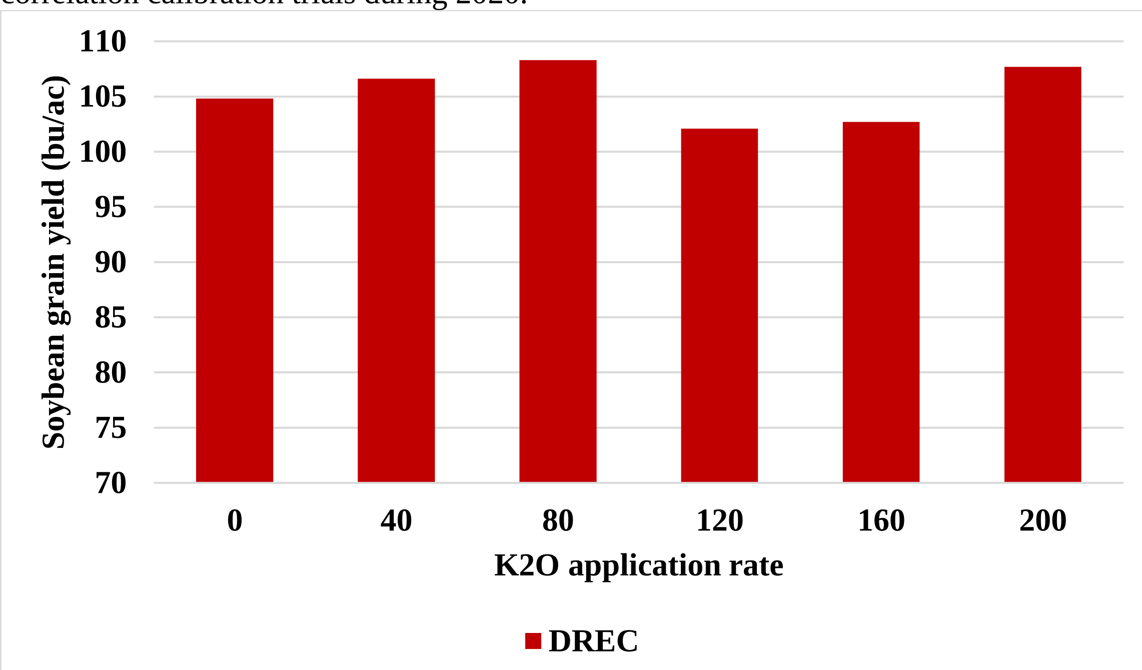

Figure 2. Potassium source trial evaluating multiple K products applied at 60 lb K20/acre for a research site at the Delta Research and Extension Center during 2020.

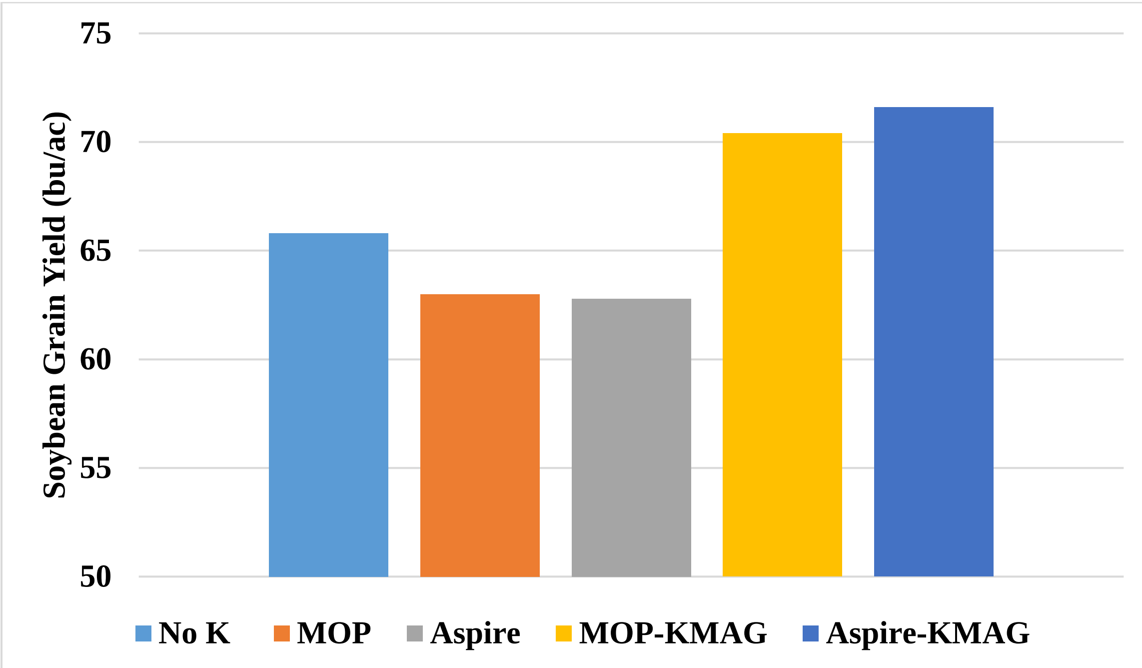

Figure 3. Soybean yield increase as a function of S fertilizer rate at all sites managed for correlation calibration trials during 2020.

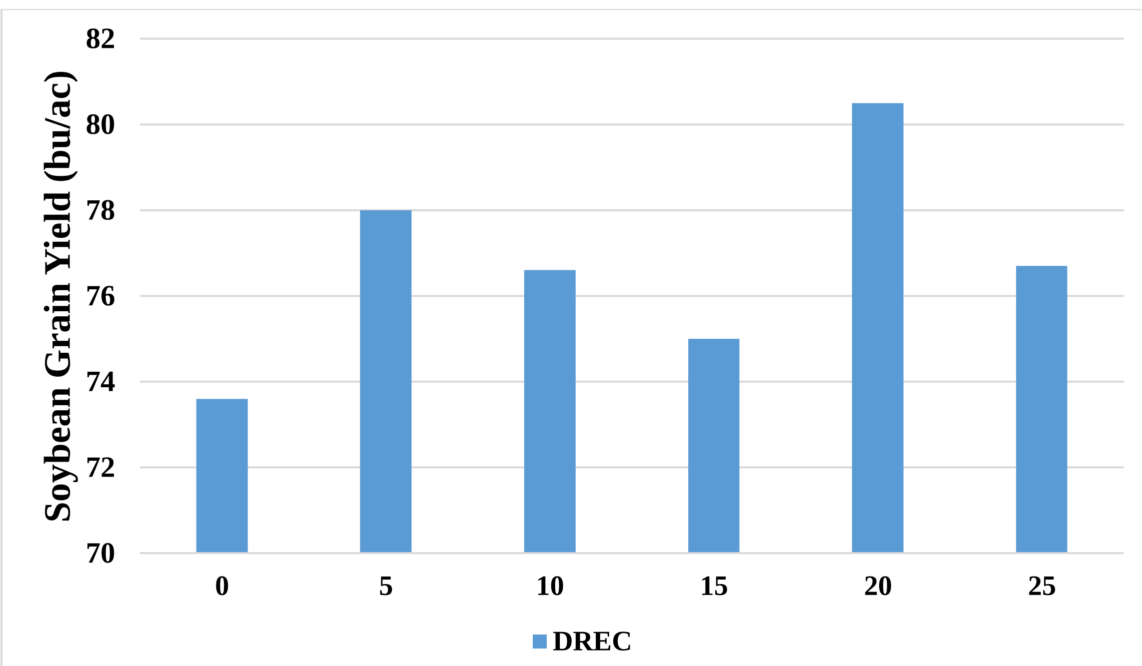

Figure 4. Soybean yield as influenced S fertilizer source and application time at a VFSL soil site at DREC managed for sulfur source response trials during 2020.