SUMMARY OF FIELD EVALUATION OF AVAIL® PHOSPHORUS FERTILIZER ENHANCER FOR COTTON

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Abstract

Phosphorus (P) nutrition has not been a major issue in cotton production on most of the alluvial soils of the Mississippi Delta where cotton has been grown. As grain crops enter the production picture, more consideration of P has been expressed as the grain crops tend to remove far more P. During this same time interest in nutrient efficiency has many producers looking at mechanism to enhancer nutrient uptake while reducing impacts on the environment from nutrients such as nitrogen (N) and P leaving the landscape. Different products have been touted in the marketplace as means of improving nutrient uptake efficiency. It is readily recognized that the best timing of application is a close as possible to the time that it is needed by the crop being grown. This study was initiated to evaluate P applications for continuous cotton under rain-fed conditions with and without AVAIL® Phosphorus Fertilizer Enhancer. The study was established at the Tribbett Satellite Farm of the Delta Research and Extension Center to evaluate P rates and AVAIL®. The P rates were 0, 20, 40, and 60 lb P/acre (0, 100, 200, and 300 lb CSP/acre) with and without AVAIL® (0.5 gal/ton). The P applications were made in the fall after harvest but prior to any fall tillage (2010 was spring application). The fertilizer material was weighed then hand-applied as a broadcast to the entire plot. All cultural practices were maintained uniformly through the growing season and received no irrigation. Seedcotton and lint yields were determined each year with the lint percent based on grab samples taken at harvest and ginned through a 10-saw micro-gin. Lint yields varied from year to year with good yields in 2010 and 2012, but less in 2011, due to drought. Over the three years of the study to date, there has been no significant response to P rates or to the addition of AVAIL®. Based on soil test P, it is unlikely that P additions would significantly increase lint yields. In the case of enhancer, if there is no response to the nutrient then if is highly unlikely that and additive would create a response. The soil test does indicate a buildup of soil test P at the higher P rates and a decline in available P where no P has been applied. To better assess the effects of an enhancer, it would be better to look for a more responsive site.

Introduction

Fertilizer nutrient management is essential for optimum cotton production across the Cotton Belt and Mid-South cotton production areas. Most emphasis has been placed on nitrogen management as this is the most mobile of the macronutrients and also the one that can undergo the most transformations within the soil environment and has the most avenues for loss before the cotton plant can take it up and utilize it for producing lint. Potassium (K) and phosphorus (P) are the other major macronutrients with potassium receiving much attention over the last few decades. Many of the Delta soils are perceived to be high in soil P and K, thus leading to many little use of fertilizer P and K on crops such as soybean. In recent years, there has been a shift away from cotton and to grain crops that remove more P and K than cotton. A corn grain yield of 180 bu/acre removes three times the P as 1000 lb lint/acre while 60 bu/acre soybean removes almost twice as much as cotton. As more grain is introduced and cotton eliminated, the greater need for P fertilization.

Most phosphorus applications are made in the fall following harvest and prior to any fall tillage operation. This allows for the fall tillage operations to incorporate the fertilizer P without additional trips across the field just to incorporate the fertilizer. Most P is applied as concentrated superphosphate (CSP, 0-46-0), as an ammoniated form (MAP, 11-48-0 or DAP, 18-46-0), or as ammonium polyphosphate (10-34-0 or 11-37-0). Most of the ammonium poly-phosphate has been applied in the spring as a starter fertilizer source. Phosphates are available to plants in various forms depending upon the soil pH, but in most soils the common forms either $H_2PO_4^-$ or HPO_4^{2-} with the latter the most common in soils with pH < 7. These negatively charged ions are not very mobile in the soil and move predominantly by diffusion with little movement as a result of mass flow. Several factors can influence P diffusion. These include: 1) soil water content, 2) tortuosity of the diffusion path, 3) phosphate buffering capacity, and 4) temperature. Over the years several “factors” have been identified that can aid in P uptake. The most common is mycorrhizal fungi that are associated with the roots of plants. These organisms increase the ability of

plants to absorb nutrients such as P, K, copper, and zinc. Under field conditions, additions of N, P or a complete fertilizer will reduce the presence and activity of mycorrhiza. The latest concept in the marketplace is AVAIL® from Specialty Fertilizer Products (SFP, Leawood, KS). Their literature states that AVAIL® is designed to be sprayed on granular phosphate fertilizers to "sequester antagonistic metals in the soil surrounding the fertilizer granule, reduce tie-up of phosphate, and make phosphate more available to the plant." AVAIL® is said to increase phosphate availability through all stages of plant growth, including the early development period crucial for increasing yield potential. In order to address these assertions a multi-year field study was established in 2010.

Research Objectives:

1. Determine the effects phosphorus applications with and without AVAIL® on seed cotton yield, lint percent, and lint yields
2. Monitor changes in soil nutrient status with time

Materials and Methods

A multi-year field research study was begun in 2010 at the Tribbett Satellite Farm (TSF) of the Delta Research and Extension Center. The rain-fed study was established on a Dundee/Forestdale silty clay loam soil (Typic Endoaqualfs). The factorial arrangement of treatments was included in a randomized complete block design with six replications (Table 1). Plots remained constant throughout the study with treatments applied to the same plots in subsequent years. The two factors in the 4x2 factorial were P rates (0, 20, 40, and 60 lb P/acre) and AVAIL® at 0 or 0.5 gal/ton. The P rates were the equivalent of 0, 100, 200, and 300 lb 0-46-0/acre. The P was applied in the spring of the initial year and in the fall of following years. The AVAIL® was applied to dry fertilizer and thoroughly mixed as directed by the supplier. The material was then weighed and hand-applied to the plots. Plots consisted of four

Table 1. Field arrangement and treatments for evaluation of phosphorus rates with and without AVAIL® Phosphorus fertilizer Enhancer. Tribbett Satellite Farm, Tribbett, Mississippi

B	8	4	1	5	7	2	6	3	5	1	4	8	6	7	2	3	B
	301	302	303	304	305	306	307	308	601	602	603	604	605	606	607	608	
B	3	6	4	7	1	8	5	2	6	3	8	1	5	2	4	7	B
	201	202	203	204	205	206	207	208	501	502	503	504	505	506	507	508	
B	1	2	3	4	5	6	7	8	4	8	2	7	3	6	1	5	B
	101	102	103	104	105	106	107	108	401	402	403	404	405	406	407	408	

Trt	P Source	AVAIL gal/T	Phosphorus Application Rate lb P/A	lb P_2O_5/A	lb 0-46-0/A
1	0-46-0	0	0	0	0
2	0-46-0	0	20	46	100
3	0-46-0	0	40	92	200
4	0-46-0	0	60	138	300
5	0-46-0	0.5	0	0	0
6	0-46-0	0.5	20	46	100
7	0-46-0	0.5	40	92	200
8	0-46-0	0.5	60	138	300

Plot Size:

4 rows @40-in
75 ft long
(1000 sq ft)

Application:

Fall application following harvest and prior to tillage (Surface Broadcast)

40-in rows, 75 ft in length. The center two rows of each plot were harvested with a commercial spindle picker adapted for plot harvest. Grab-samples were taken during the harvest process and then ginned through a 10-saw micro-gin to determine lint percentage and lint yields. Soil samples were taken from each plot prior to the next P application. Those samples were air-dried, ground, and submitted to the Soil Testing and Plant Analysis Laboratory at Mississippi State University. All data was analyzed with SAS (ANOVA) with mean separation examined with Fisher's Protected Least Significant Difference at a 5% level of significance.

Results and Discussion

Cotton response to phosphorus (P) fertilization with and without AVAIL® Phosphorus Fertilizer Enhancer was evaluated for three years under rain-fed conditions at the Tribbett Satellite Farm of the Delta Research and Extension Center. The research field has been in continuous cotton production since the mid 1990's with yields ranging from one to three bales/acre depending upon rainfall amounts and distribution. Four P rates, 0, 20, 40, or 60 lb P/acre (0, 100, 200, or 300 lb 0-46-0/acre) were applied in the fall after harvest (except 2010 crop year) and stalk shredding but prior to any fall tillage. After application, the area was disked, subsoiled, and hipped in the fall with the beds left undisturbed until planting in the spring. The field layout of the study, along with treatments, is shown in Table 1. The 0-46-0 (CSP) was treated with AVAIL® then weighed for each plot. The fertilizer P and AVAIL®-treated P was hand-applied in a broadcast pattern. All other cultural practices were held constant throughout each growing season. A total of 150 lb N/acre was applied as urea-ammonium nitrate solution (32% N) with 60 lb N/acre applied prior to planting and the remaining 90 lb N/acre applied as a sidedress at the pin-head to match-head square growth stage. The fertilizer N was "knifed-in" to either side of the row and 10 inches to the side of the row. The center two rows of each plot were harvested with a two-row spindle picker adapted for plot harvest. Grab samples were taken at harvest and used to determine lint percent and lint yield. The grab samples were ginned through a 10-saw micro-gin with no lint cleaning. Samples were weighed at the time of harvest and then allowed to equilibrate in a dry environment. Samples were again weighed at the time of ginning with the original weight used in the calculation of lint percent.

Table 2. Summary of ANOVA (Pob. > F) for evaluation of phosphorus rates with and without AVAIL® Phosphorus Fertilizer Enhancer. Tribbett Satellite Farm, Tribbett, Mississippi

Analysis of Variance (SAS)

Factor	Component	Prob. > F		
		2010	2011	2012
P Rate	Seedcotton	0.3397	0.3207	0.3064
	% Lint	0.3399	0.0073	0.6520
	Lint	0.1881	0.2977	0.1851
AVAIL	Seedcotton	0.1566	0.3387	0.5901
	% Lint	0.2445	0.8907	0.5095
	Lint	0.0892	0.3471	0.4851
Interaction	Seedcotton	0.7212	0.8469	0.8849
	% Lint	0.9806	0.0610	0.9664
	Lint	0.7610	0.7823	0.8961
Treatment	Seedcotton	0.4565	0.6175	0.6954
	% Lint	0.6545	0.0104	0.9317
	Lint	0.2677	0.5690	0.5286

Lint yields have been summarized for each year and presented in Figures 1 to 3. The Analysis of Variance (ANOVA) has been summarized and shown in Table 2 for seedcotton yield, lint percent, and lint yield. A 5% level of significance was chosen apriori and maintained through the three years. In 2010, there was a positive trend with AVAIL®, however, it was not significant at the 5% level. The top half of Table 2 is the Main Effects analysis, while the lower portion was the interaction analysis. In 2010, (Figure 1) lint yields were 1239, 1311, 1279, and 1274 lb lint/acre for the 0, 20, 40, and 60 lb P/acre rates, respectively when averaged across AVAIL® rates. The difference between the UTC and AVAIL-treated P rates ranged from 18 to 81 lb lint/acre but was not statistically significant. In 2011, (Figure 2) overall lint yields were much lower (45% of 2010) than those observed in 2010. Lint yields were 553, 574, 576, and 605 lb lint/acre for the 0 to 60 lb P/acre rates, respectively. There were no differences with the AVAIL® amendment. The 2012 yields (Figure 3) were much better than 2010 (25% higher) or 2011 (151% higher). Lint yields for the 0, 20, 40, and 60 lb P/acre rates were 1404, 1493, 1460, and 1444 lb lint/acre when averaged across the other factor. Like 2011, there was again no lint yield response to the addition of AVAIL® to the phosphate fertilizer.

Soil samples have been collected from each plot following harvest. Multiple cores were taken to a depth of six inches and composited for soil analyses. Averaged across all plots in the study in 2010; pH = 6.3, Extractable K = 642 lb K/acre, Extractable P = 130 lb P/acre and % Organic Matter = 1.42%. The extractable P levels are in the high range and thus would indicate an unlikely response to fertilizer P. Soil samples following the 2011 cropping season

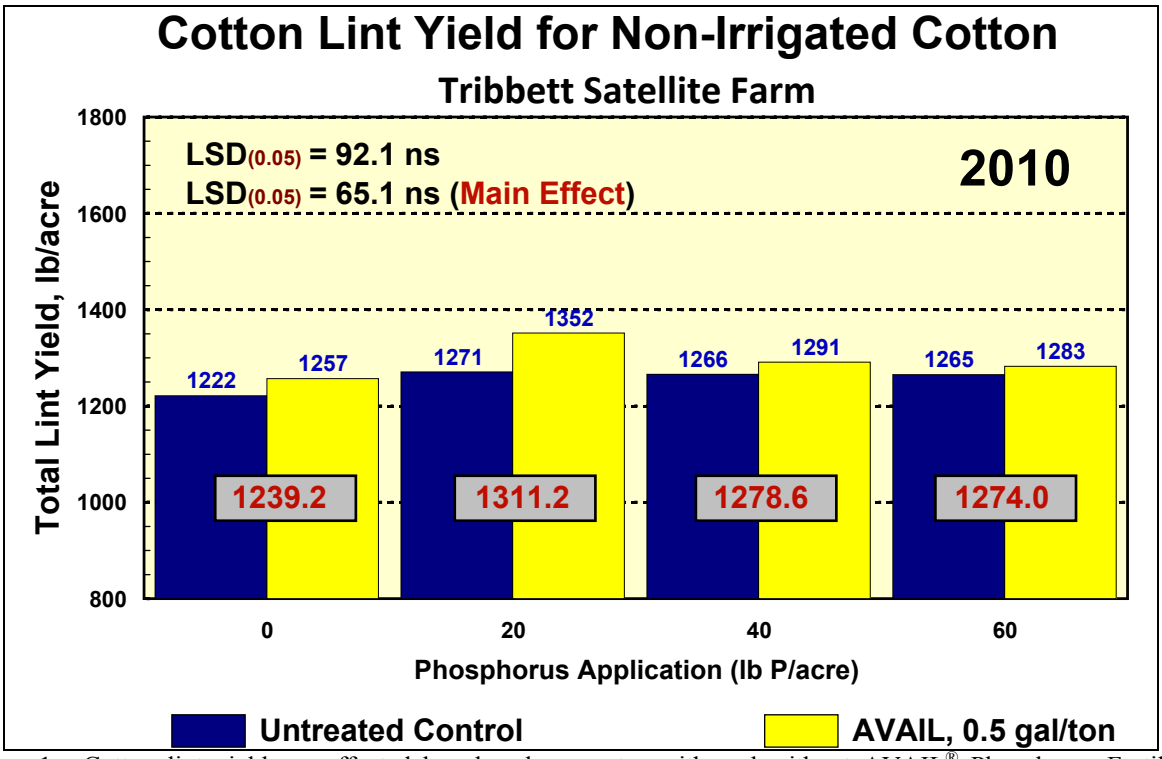

Figure 1. Cotton lint yields as affected by phosphorus rates with and without AVAIL® Phosphorus Fertilizer Enhancer. Interaction effects and main effect for P rate. Tribbett Satellite Farm, Tribbett, Mississippi. 2010 Season (non-Irrigated)

showed a decrease in soil test levels for pH, P, and K. The soil test phosphorus levels for 2011 are shown in Figure 4. There is a increase in extractable P levels with increasing P rates. The estimated P removal for cotton is 12 lb P/1000 lb lint acre or 0.012 lb P/lb of lint. Based on these assumptions with the yields observed one should expect the soil test P levels to be increasing, and that appears to be the case. The 2012 samples have yet to be analyzed. After three years, research has not shown a significant response to P application or any response to adding AVAIL® to the fertilizer P. With the current soil test recommendations for P on cotton, there would be no recommendation for added P on this area. Soil test do indicate a increase in soil test levels with added P but no additional yield.

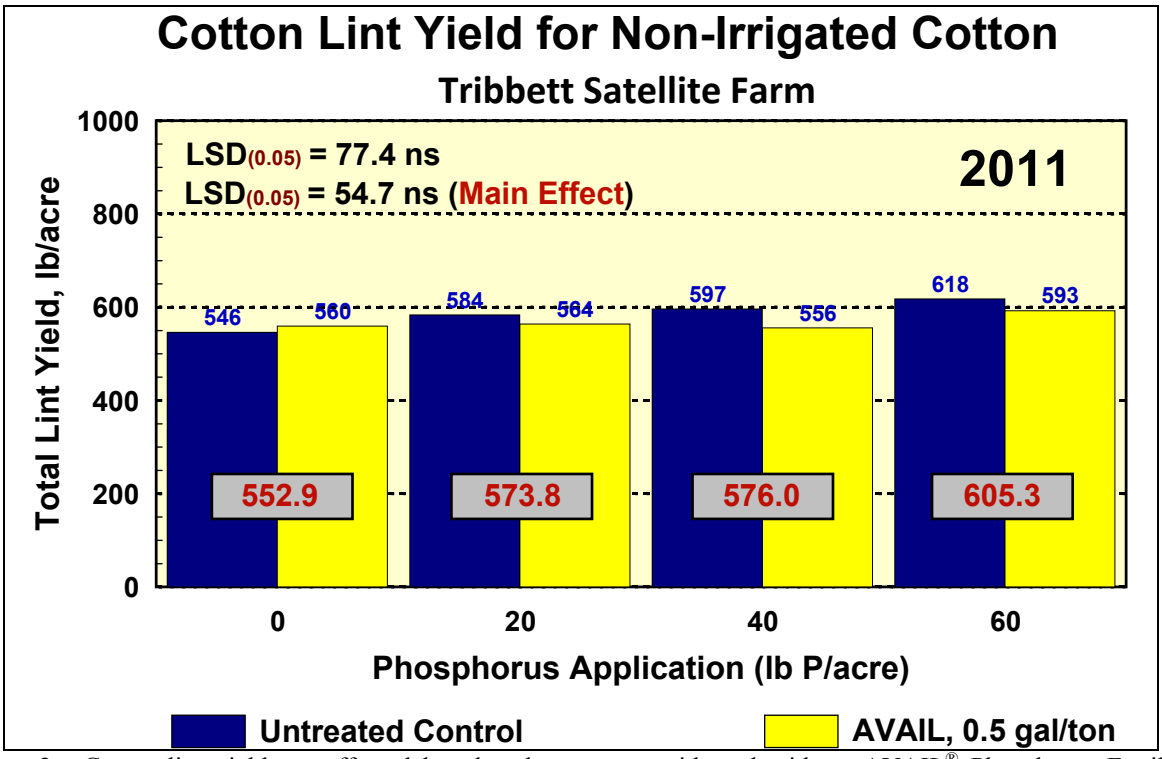

Figure 2. Cotton lint yields as affected by phosphorus rates with and without AVAIL® Phosphorus Fertilizer Enhancer. Interaction effects and main effect for P rate. Tribbett Satellite Farm, Tribbett, Mississippi. 2011 Season (non-Irrigated)

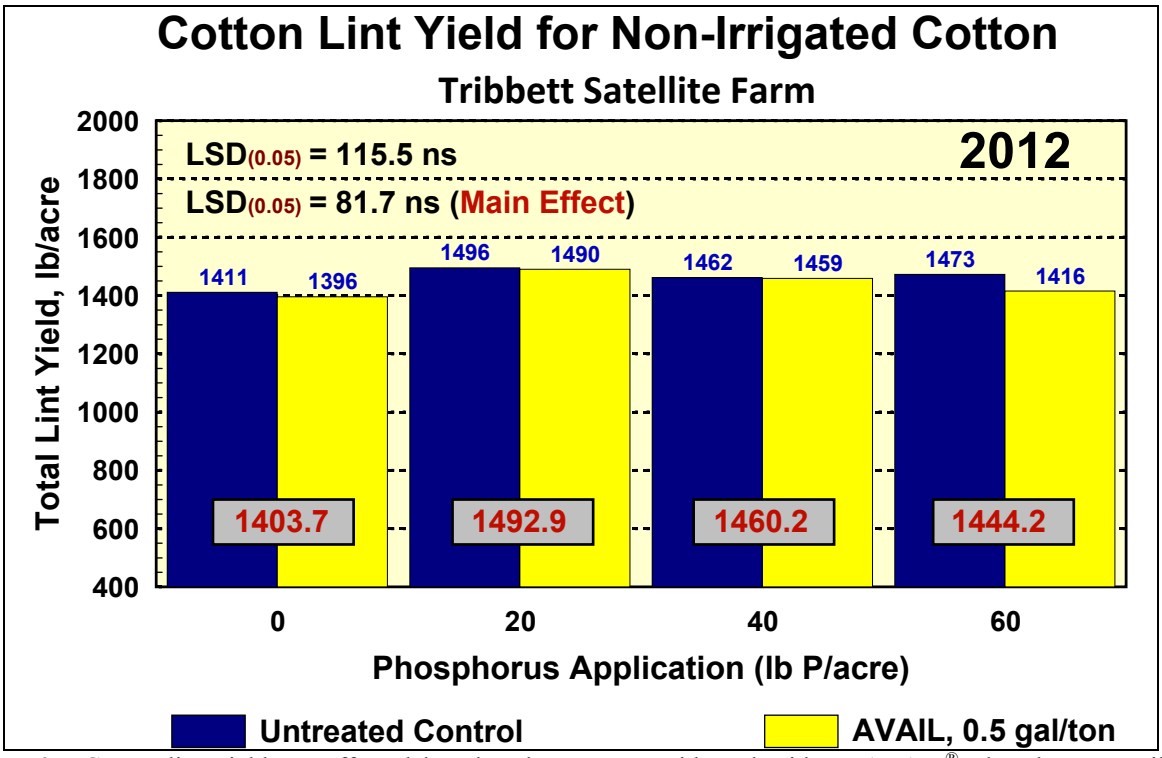

Figure 3. Cotton lint yields as affected by phosphorus rates with and without AVAIL® Phosphorus Fertilizer Enhancer. Interaction effects and main effect for P rate. Tribbett Satellite Farm, Tribbett, Mississippi. 2012 Season (non-Irrigated)

The addition of AVAIL® makes no difference when no P is needed. Further evaluations should be considered on P responsive sites. Studies are under way across the state to evaluate the current soil testing recommendations for the state in light of changing crops mixes and more grain crops. Adding nutrient uptake enhancers should only be considered after proven success. Soil testing is the key to successful fertilizer management and should be utilized on all production areas of the state. For more information on soil testing contact your local extension office or the Soil Testing and Plant Analysis Laboratory at Mississippi State University.

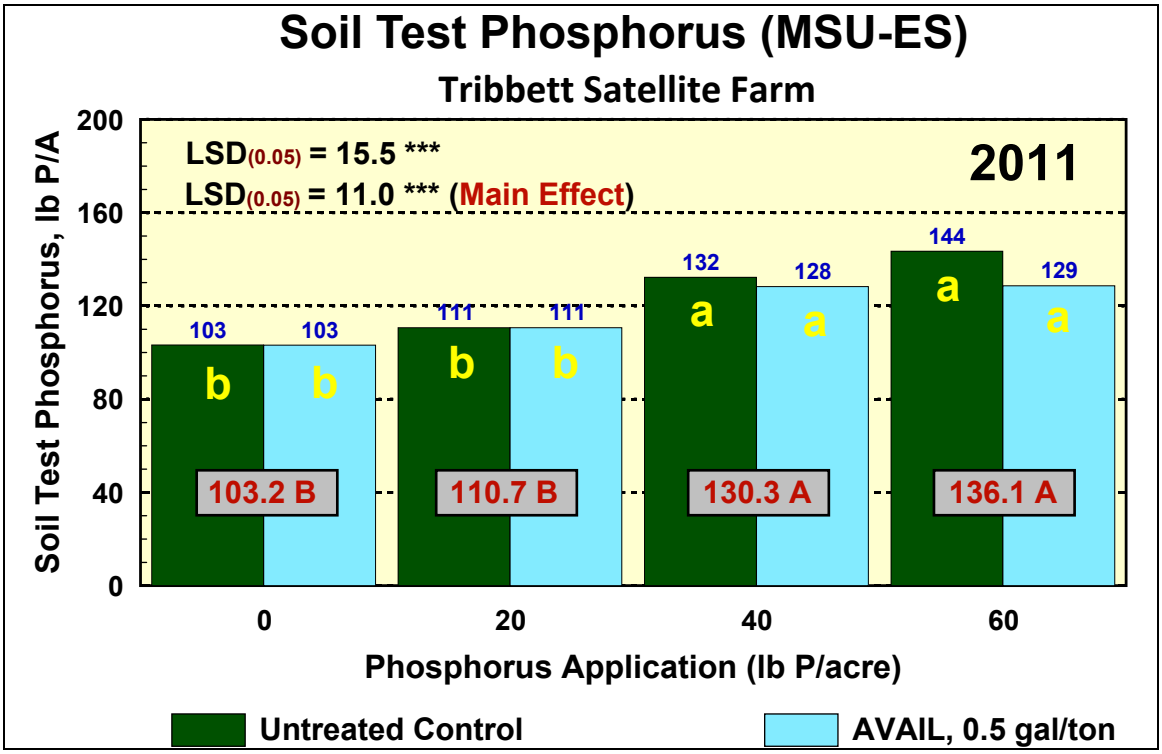

Figure 4. Summary of soil test phosphorus following the 2011 growing season from an evaluation of phosphorus rates with and without AVAIL Phosphorus Fertilizer Enhancer. Tribbett Satellite Farm, Tribbett, Mississippi