MISSISSIPPI SOYBEAN PROMOTION BOARD
PROJECT NO 21-2015 (YEAR 3)
2015 Annual Report

TITLE: Response and net profit of genetically enhanced and conventional soybean to fertilizer recommendations from soil testing laboratories on low nutrient status soils in Mississippi produced with rain-fed and irrigated environments.

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BACKGROUND AND OBJECTIVES

The adoption of the Early Soybean Production System in Mississippi has promoted the use of early maturing varieties, which typically have an indeterminate growth habit. Since indeterminate varieties have overlapping vegetative and reproductive growth stages, new growth competes with pod development causing an increased demand for K.

Soil test results separated by major land resource areas at the MSU Soil Testing lab indicate that soil outside the Delta would benefit from K fertilization. Therefore, this research is designed to cooperate with soybean producers to identify nutrient-deficient land and conduct fertilizer response studies with a major emphasis on K deficiency. Results from this research will be used to confirm or adjust MSU Soil Testing recommendations for producers to utilize in fertilizer programs.

Justification

Soybeans are an increasingly important crop in Mississippi agriculture. In 2010, soybean was 3rd in dollar value in Mississippi behind forestry and poultry, with a value of $846 million. In 2012, there were more than 2.1 million acres of soybean planted in Mississippi, which is up 17% from 2011. Research indicates that new varieties have provided a gradual genetic yield increase of 22 to 26 lb/ac over time. A study conducted in 2009 with 18 southern soybean cultivars to validate the yield difference between old vs. new cultivars suggests that 79% of the yield increase can be attributed to increased seed production compared to 21% to an increase in seed size.

As yield of soybean increases, so does removal of soil nutrients. If the level of K in the soil becomes limited, soybean plants will begin to develop yellowing leaves beginning at the leaf margins, moving inward on the leaf. Deficiency symptoms will usually appear on older leaves lower on the plant first. In severe cases nearly the entire plant will show these symptoms of deficiency. Soybean that are deficient will have reduced yields compared to soybean that have been supplemented with K fertilize. It has also been determined that seed produced from K-deficient soybean have lower oil and K concentrations.

Maintaining a sufficient level of K to the soybean plant may become even more important in the future as yield continues to increase due to the selection of desirable lines with high and stable yields, further advancement of resistance to nematode pests, and other improved genetic gains.

Over the past decade, soybean yield level goals have been promoted to maximize yield potential, and some laboratories recommend specific "moving target" fertilizer rates based on higher yield expectations. Therefore, research will be designed to validate fertilizer recommendations on K-deficient soil from several soil testing laboratories on new vs. old cultivars produced in no-tillage or tilled environments with rainfed vs. irrigated management practices. This study will use these factors to create several scenarios specific to the production practices that soil test laboratories use to tailor fertilizer rate recommendations.

Current research conducted at the Pontotoc Branch Experiment Station indicates recommended rates of K from both public and private sector laboratories improve soybean yield grown on K-deficient soil. However, there was a wide gap in profit margin to the grower between the recommendations. This project will address additional factors such as yield level goals with new and old cultivars produced with rainfed and irrigated conditions. Inclusion of these additional factors should "narrow the gap" in the profit margin between different laboratory recommendations, and validate the need (or not) for performance-driven levels of fertilizer inputs.

Objective(s)

Objective 1. Validate current soil testing recommendations from several soil testing facilities for potassium (plus other nutrients) in soybean produced on soil low in potassium under rainfed and irrigated environments. *Recommendations vary among laboratories with some labs using yield goal levels, while others promote a single use rate. This research will provide insight to growers for making fertilizer management decisions based on the lab they prefer to utilize.*

Objective 2. Identify optimal K_2O fertilizer rate for new high yielding soybean compared to old varieties in rainfed and irrigated environments. *In addition to rate validation and optimization, these results could advance variable rate technologies through adjustments to equations utilized in field prescription recommendations in the future…i.e. rate based on specific soil level, not index range.*

Objective 3. Determine the economic benefits of each fertilizer rate recommended by several soil testing laboratories in Mississippi and adjacent states. *Preliminary results from previous research indicate that recommendations from soil test laboratories are different. Higher recommended fertilizer rates may or may not maximize yield and can violate the "law of diminishing returns" for crop revenue.*

MATERIALS AND METHODS

A research study was established in 2012 and repeated in 2013, 2014, and 2015 on the same plot area on a Falkner silt loam in the Hill region of Mississippi at the Pontotoc Ridge-Flatwoods Branch Experiment Station near Pontotoc, MS. This location was selected due to limited soil nutrient levels in order to promote the highest potential for plant response to all fertilizer treatments.

The experimental design was a randomized complete block with 4 replications in a no-tillage, rainfed and irrigated environments. Plot size was 10 x 40 ft containing four 30-inch-wide rows. A soil sample was collected from each treatment, prepared for testing, and a portion of the same sample was analyzed by four soil testing laboratories (one public and three private).

Treatments include soil test recommendations from each laboratory with the private laboratories having recommendations for a low and high yield goal. Additional treatments included a fertilizer rate regime that reached beyond the recommended rates at the initiation of the study, and a poultry litter treatment that targeted the lowest K recommendation of the different laboratories, which was calculated using the percentage of K in the litter.

All treatments were applied to two soybean varieties—Hutcheson, an older conventional variety, and AG 5332, a newer RR2Y variety. Fertilizer used in the study was potassium (K) 0-0-60, phosphorus (P) 0-46-0, nitrogen (N) 33-0-0, magnesium sulphate 36%, manganese 13%, boron 17.5%, copper 25.1%, zinc 35.5% and elemental sulfur (S) 90%.

Soybean was planted on June 8, 2015 followed by the hand-application of fertilizer treatments during the afternoon on June 8, 2015. Soybean leaf samples were collected on July 30, 2015 at the R1-R2 growth stage for leaf tissue nutrient analysis. The irrigated portion of the trial was irrigated 6 times beginning on July 31, 2015 and ending September 23, 2015. Irrigation was made based on the University of Arkansas Irrigation Scheduler computer program.

The two center rows of each plot were harvested on Nov. 11, 2015 with an Almaco PMC 20 combine equipped with a HarvestMaster weigh system, which recorded plot weight and seed moisture. A seed sample was collected from each plot for conducting seed nutrient analysis. Yields were adjusted to 13% seed moisture. Analysis of variance was conducted and means were separated using Fishers protected LSD (α=0.05).

RESULTS AND DISCUSSION

Soil analysis from the different laboratories indicated a wide range of K recommendations; with the lowest recommended K rate of 0 lb K_2O/acre to the highest rate of 180 lb K_2O/acre. Soybean yield ranged from 20.3 to 60.7 bu/acre, with an average yield of 45.6 bu/acre. Soybean yield was higher than the untreated check for all soil test laboratories treatments when averaged across varieties and irrigation treatments, but there was no difference among soil test laboratory treatments. There was no difference between irrigated and nonirrigated yield when averaged across all treatments and varieties. Yield for the potassium rate regime ranged from 38.2 to 48 bu/acre when averaged across all varieties and irrigation treatments.

While there was no difference among treatment in the potassium rate regime, all yields were higher than the untreated check, which had a yield of 29.4 bu/ac when averaged across all varieties and irrigation treatments. Yields were 49.8 and 53.67 bu/acre when averaged across all treatments and irrigation practices for Hutcheson and AG 5332, respectively. Soybean tissue and seed samples for 2 years of the study have been analyzed, while the final year's data are currently being prepared for nutrient content analysis. An economic analysis will be conducted at the completion of the trial to compare net returns with each fertilizer treatment.