Mississippi Corn Promotion Board
2021 Progress Report

Project Title: Strip-Tillage and Fertilizer Placement Effects on Irrigated and Dryland Corn Production

PI: Gurbir Singh

Department: Delta Research and Extension Center, Stoneville, MS

Project Summary (Issue/Response)

Most producers in the Mississippi Delta perform multiple tillage operations before crop planting including subsoiling, and then disking, hipping, and rolling for bed formation. Subsoiling alleviates compaction in deep soil horizons, while surface tillage ensures good soil to seed contact. Conservation management practices that minimize surface tillage while maximizing yield, net returns, and irrigation/fertilizer use efficiency are needed in the mid-southern USA. Strip-tillage with a deep shank is an alternative practice to the conventional tillage system. Strip-tillage generally disturbs 25% of the plow layer, while the remainder of the soil and surface residues is undisturbed. Strip-till rigs are designed to band dry or liquid fertilizer using a shank when the tillage operation is performed. Banding fertilizer below the seedbed increases the probability for plant uptake while minimizing loss through runoff. The overall goal of this study is to quantify the effects of tillage, irrigation, and fertilizer placement on corn production. Specific objectives are: to quantify the effect of strip tillage, conventional tillage, subsoiling and fertilizer placement on stand establishment, corn yield and quality, nutrient uptake, and P and K use efficiency; to evaluate the effects of tillage systems with P and K placement under irrigated and non-irrigated conditions on soil water availability, irrigation water use efficiency, compaction, and soil P and K test values; and to determine the economic feasibility of strip-tillage for Mississippi corn growers. Sub-soiling and strip tillage both increased corn grain yield by 18.5 and 13.7 bu/ac when compared to conventional tillage under irrigated conditions. Under dryland conditions, conventional tillage yielded 14.0 and 11.5 bu/ac less compared to sub-soiling and strip tillage treatments, respectively. Potassium fertilizer when deep banded (incorporated) with strip-tillage at 8-inch depth retained the highest potassium in the soil at the depth of 6-12 inches suggesting that potassium nutrient losses were reduced when compared to other tillage by placement treatments. Under irrigated conditions for fall 2021, soil test P for strip-tillage incorporated treatment was 27.3 mg/kg and was at least double in P nutrient concentrations when compared to all other tillage by placement treatments. Overall, soil sampling results indicate that if the goal of the grower is to maintain and retain P and K fertilizer in the soil, a best management practice would be to incorporate the P and K fertilizer below the rooting depth.

Project Results/Outcomes

Corn grain yield

Sub-soiling and strip tillage both increased corn grain yield by 18.5 and 13.7 bu/ac when compared to conventional tillage under irrigated conditions (Figure 1). Under dryland conditions, conventional tillage yielded 14.0 and 11.5 bu/ac less compared to sub-soiling and strip tillage treatments, respectively. No significant differences were obtained between sub-soiling and strip-tillage treatments for corn grain yield when pooled over fertilizer placement treatments. Similarly corn grain yields among strip-tillage and sub-soiling treatments indicate that 1-pass operation of strip-tillage can be economically beneficial to the MS growers and have the potential to replace sub-soiling with conventional tillage which is at least a 3 to 4 tillage passes operation.

Project Results

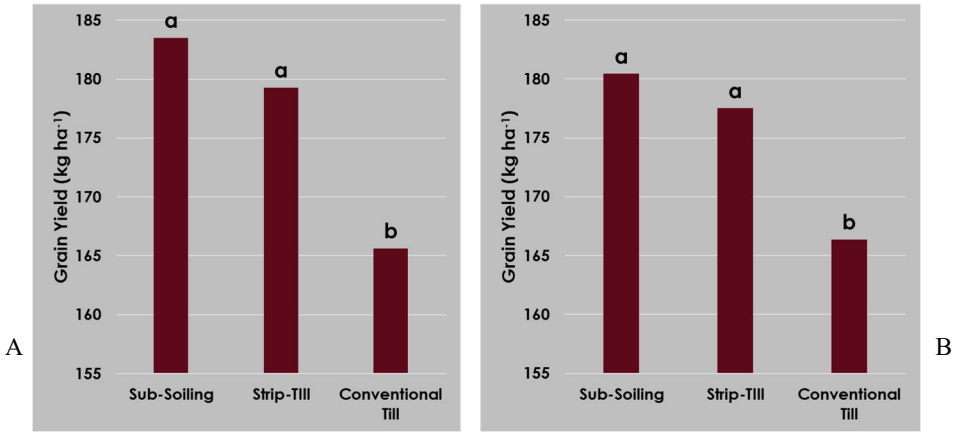

Figure 1. Two-year (2020 and 2021) mean corn grain yield averaged over fertilizer placement treatments under irrigated (A) and dryland (B) conditions. Mean values followed by the same letters within a column indicate no significant differences between treatments at alpha = 0.05.

Soil fertility

In spring 2021 soil sampling, a three-way interaction between tillage, fertilizer placement, and depth was significant for mehlich-3 extractable potassium ($p<0.05$, Table 1). Potassium fertilizer when deep banded (incorporated) with strip-tillage at 8-inch depth retained the highest potassium in the soil at the depth of 6-12 inches suggesting that potassium nutrient losses were reduced when compared to other tillage by placement treatments (Figure 2). Under irrigated conditions for fall 2021, soil test P for strip-tillage incorporated treatment was 27.3 mg/kg and was at least double in P nutrient concentrations when compared to all other tillage by placement treatments (Figure 3). This suggested that a zone of high soil fertility was created with two years of strip-tillage band application of P fertilizer. Similarly, strip-tillage incorporated soil test K was highest during fall 2021 soil sampling and was significantly different from all other tillage by placement treatments except strip-tillage broadcast (Figure 3). Overall, soil sampling results indicate that if the goal of the grower is to maintain and retain P and K fertilizer in the soil, a best management practice would be to incorporate the P and K fertilizer below the rooting depth. Over time bands of high fertility can be created in the field and precision planting on these high fertility bands can be accomplished using RTK planting systems.

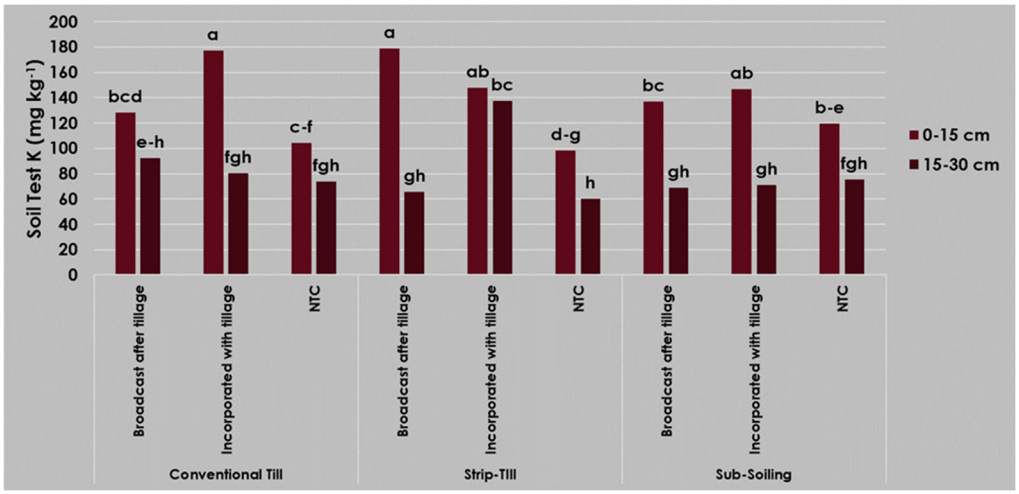

Figure 2. Mean values of soil test K measured from spring 2021 soil sampling at two depths at 0-6 and 6-12 inches under three tillage and three placement treatments for irrigated conditions. Mean values followed by the same letters within a column indicate no significant differences between treatments at alpha = 0.05.

Project Results

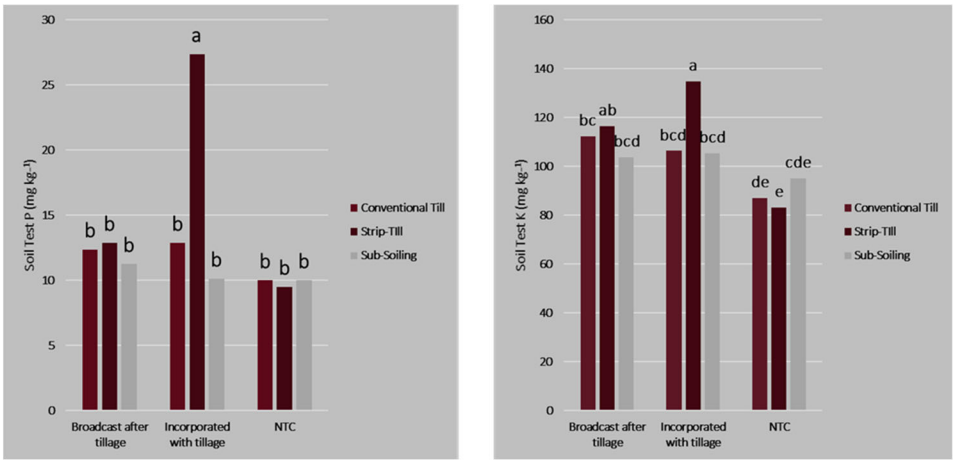

Figure 3. Mean values of soil test P and K measured from fall 2021 soil sampling under three tillage and three placement treatments for irrigated conditions. Mean values followed by the same letters within a column indicates no significant differences between treatments at alpha = 0.05.

Project Impacts/Benefits

Results from this project will be shared with producers in field days organized by NCAAR-DREC and will be discussed at the farmer/grower meetings. These results are from the two years data. Continuous application of phosphorus and potassium as deep banding would result in creating zones of high phosphorus and potassium soil fertility under the planted seedbed. The results from soil sampling showed an increasing trend of higher soil P and K in strip-tillage banded treatments. With precision planting using RTK on the same seedbeds, it is anticipated that farmers would benefit from strip-tillage deep banding tillage practice. Creating a zone of high fertility and further planting corn on the same seedbed will eventually result in reduced fertilizer input costs for P and K. For year like 2022 when the fertilizer prices has doubled, the strip tillage practice can potentially benefit growers. Farmers who have been doing strip tillage for a long time and who have built up zones of higher soil fertility have an option to either skip P or K application all together or can put half the recommended rate of fertilizer as band application with strip-tillage equipment. Additional data from coming year will help answer the economic feasibility of strip-tillage and banding fertilizer placement system for Mississippi corn growers. Future research should focus on how much P and K fertilizer can be reduced with strip tillage banding compared to the conventional broadcast fertilizer application. A biggest question is for how long a grower can skip the application of P and K with still maintaining yields when zone of high soil fertility exist in the field created with banding fertilizer.

Project Deliverables

Hankins, J.C. 2021. Conventional and Reduced Tillage Systems with Fertilizer Placement in Irrigated and Dryland Corn. YouTube https://www.youtube.com/watch?v=Wb6fefEQ3vo.

Hankins, J.C., Kaur, G., Singh, G., and Gholson, D. 2021.Strip and conventional tillage systems with fertilizer placement affects corn production and soil properties. ASA-CSA-SSSA International Annual Meeting, Salt Lake City, UT. Nov. 7-10.

Singh, G., Kaur, G., Krutz, J. 2021. Irrigated and dryland corn production under strip-tillage and conventional tillage. 24th annual National Conservation Systems Cotton and Rice Virtual Conference, Feb. 10.

Singh, G., Kaur, G., Bararpour, T., Krutz, L.J. 2020. Strip-tillage and fertilizer placement effects on irrigated and dryland corn production. ASA-CSA-SSSA International Annual Meeting Virtual. Nov. 9-13.