Mississippi Corn Promotion Board 2020 Progress Report

Title: Strip-tillage and fertilizer placement effects on irrigated and dryland corn production

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Project Summary

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. Corn silage yield was highest for strip-tillage and subsoiling tillage treatments when combined over the irrigation and fertilizer placement. Potassium uptake was 123 lb/ac for stip-tillage treatments which was 22 lb/ac higher compared to conventional tillage treatments. Corn grain yields were higher (20-26 bu/ac) in both subsoiling and strip tillage treatments compared to conventional tillage when combined over the irrigation and fertilizer placement treatments. Phosphorus and potassium use agronomic efficiencies were highest for strip-tillage treatments when compared to the other two tillage systems. There were no differences in grain quality based on the tillage systems, however, the irrigated corn had significantly higher grain protein compared to dryland corn. Soil test phosphorus at the end of the season was highest for strip-tillage deep banding for the first-year end soil sampling.

Project Results/Outcomes

In this project, we compared existing tillage systems that are conventional tillage and conventional tillage with subsoiling to strip-tillage for both dryland and irrigated corn. This study was established at the National Center for Alluvial Aquifer Research (NCAAR), Delta Research and Extension Center (DREC). A field with a history of continuous corn with low to medium soil phosphorus and potassium values was selected for this research. The soil series of the research field was Bosket very fine sandy loam. Conventional tillage operation involved two passes of disk followed by a pass of hipper and a pass of do-all bed preparation before planting. The subsoiling involved a single pass of parabolic subsoiler in addition to all operations of conventional tillage. The strip-tillage included a single pass operation with orthman 1tripr strip-tiller which had a vertical tillage shank of 9 inches that tilled soil underneath the seedbed. We also evaluated phosphorus and potassium fertilizer placement in the split plots under three tillage systems. Fertilizer placements included broadcasting fertilizer and incorporating it with tillage, broadcasting fertilizer after tillage operation, and banding fertilizer with strip-till below the seedbed. The experimental design was a split-split plot design with four replications. Corn hybrid DKC70 -27 was planted on April 6, 2020, at a seeding rate of 38,000 seeds/acre in a twin-row pattern. The fertilizer rates applied to corn were 232-50-100 N-P2O5-K2O lbs/acre. Corn aboveground biomass sampling was conducted on August 8, 2020, for determining corn silage yield and its phosphorus and potassium uptake. Due to the timely precipitation, irrigation was only applied three times over the whole growing season. Two center rows of each 4-row plot were harvested on Sept. 11, 2020, using a Kincaid 8xp plot combine. At the time of harvesting, grab samples were collected to determine grain moisture, bushel test weight, seed index (100-seed weight), and grain quality (protein, starch, and oil). Soil samples were collected at two depths (0-6 and 6-12”) after harvesting and sent to a lab for available nutrient analysis.

Project Results

Strip tillage increased silage yield by 16 and 13% compared to the conventional tillage system. Subsoiling increased corn grain and silage yield by 12% than the conventional tillage system. There were no significant differences between the strip-tillage and sub-soiling tillage treatments for corn grain yield and silage yield. Potassium uptake in corn biomass was 123 lb/ac which was 22 lb/ac higher compared to conventional tillage treatments. Bushel test weights were 56.92 and 56.69 lb/bu for strip-tillage and subsoiling treatments which were at least 0.78 lb/bu higher compared to conventional tillage treatment. Phosphorus and potassium use agronomic efficiencies were highest for strip-tillage treatments 145 and 38, respectively when compared to the other two tillage systems. There were no differences in grain quality for oil and starch content based on the tillage systems, however, the irrigated corn had significantly higher grain protein compared to dryland corn. Soil samples for residual P and K were collected after corn harvest. When combined over the tillage treatments the incorporated potassium in 0–6-inch soil depth was higher than broadcast after tillage treatments and no-fertilizer control treatments. Residual soil test phosphorus at the end of the season was highest for strip-tillage deep banding for the first-year end soil sampling and was significantly different from subsoiling treatments (Figure 1).

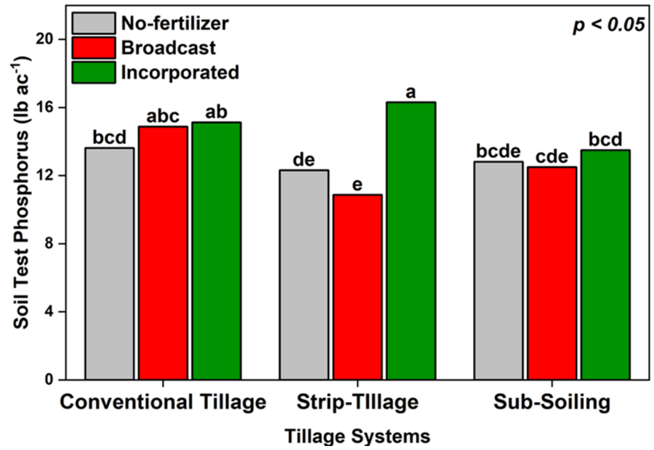

Figure 1. Mehlich-3 extractable soil phosphorus after harvesting of corn in 2020 for tillage and fertilizer placement treatments. Means followed by the same letter on the vertical bars of the graph do not differ significantly at P<0.05.

Irrigation	Tillage Systems	Fertilizer Placement	Grain Moisture	Test Weight	Grain Yield	P Agronomic Efficiency	K Agronomic Efficiency	Grain Protein
			%	lb/bu	bu/ac		g/kg	
Dryland			**12.15b**	**56.21b**	181	110	29	**88.6 b**
Irrigated			**13.26a**	**56.80a**	178	114	30	**98.1 a**
	Strip-tillage		12.85	**56.92a**	**190a**	**145a**	**38a**	93
	Sub-soiling		12.80	**56.69a**	**184a**	**87b**	**23b**	93
	Conventional tillage		12.48	**55.91b**	**164b**	**103b**	**27b**	93.9
		No-fertilizer	12.50	**55.72b**	**150b**	-	-	**96.2 a**
		Broadcast	12.92	**56.83a**	**195a**	114	30	**92.6 b**
		Incorporated	12.70	**56.97a**	**193a**	109	29	**91.2 b**

Table 1. Influence of irrigation, tillage systems, and fertilizer placement treatments on grain moisture, test weight, grain yield, phosphorus (P) & potassium (K) agronomic efficiency, and grain protein. Means followed by the same letter within a column do not differ significantly at P<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 first-year data and we should be cautious in interpreting these results as continued data collected for the next two years will dictate the overall benefits of the strip-tillage systems for Mississippi corn growers. 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 for first year-end soil sampling showed an increasing trend of higher soil P 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. Additional data from coming years will help answer the economic feasibility of strip-tillage and banding fertilizer placement system for Mississippi corn growers.

Project Deliverables

1. Hankins, C., Singh, G., and Kaur, G. 2021. Conventional and Reduced Tillage Systems with Fertilizer Placement in Irrigated and Dryland Corn. Annual Meeting Southern Branch of the American Society of Agronomy Jan 30 - Feb 1, 2021, Virtual Live Conference. (Talk)

2. Singh, G., Kaur, G., and Krutz, J. 2021. Irrigated and Dryland Corn Production under Strip-tillage and Conventional tillage. 24th annual National Conservation Systems Cotton and Rice Conferences 2021. (Talk).

3. Singh, G., Kaur, G., Bararpour, T., and Krutz, J. 2020. Strip-Tillage and Fertilizer Placement Effects on Irrigated and Dryland Corn Production. 2020 Annual ASA-CSSA-SSSA Meeting – Virtual. November 9-13, 2020. (Poster).

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