TILLAGE SYSTEMS FOR COTTON PRODUCTION ON LOESS SOILS IN CENTRAL MISSISSIPPI

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INTRODUCTION

The Brown Loam soil resource area of Mississippi is a narrow band (about 60 miles wide) of loessial soil that extends from about Natchez, MS almost to Memphis, TN. The region is classified as soil with high erosion capability and thus, conventional tillage row crop production is influenced by the 1985 and 1990 Food Security Act. Interest in reduced tillage cotton production systems has increased in central Mississippi because of the erosive capability of most soils in the region and government regulations restricting some tillage operations. Although each field is different with respect to meeting compliance requirements, generally, tillage operations are not allowed from the time of harvest until March 15-April 1, depending on soil type and slope (Dale Bullock, USDAISCS, Personal Communication). A minimum of 30% ground cover crop residue must be present at the time of planting if tillage system is the sole component for meeting conservation compliance. A cover crop must be planted to achieve the ground cover requirement if tillage is performed in the fall. Species of cover crop used (crimson clover, hairy vetch, wheat and native vegetation) did not significantly affect seedcotton yield in a three year study on Brown Loam soils in north Mississippi (Bloodworth and Johnson, 1992). In the same study, no-till cotton produced greater seedcotton yield than conventionally tilled cotton in two of the three years. Plant populations responded differently to the tillage treatments in each year of the study.

In Arkansas, in a two year study, conventionally tilled cotton grown in either 30- or 38-inch rows produced significantly greater lint yield per acre than no-till cotton (Keisling et al., 1994). However, plant stands per row foot were identical across row spacings and within tillage treatments resulting in greater plant population for 30-inch versus 38-inch row spacings.

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Deep tillage (subsoiling) has been documented to increase conventional tillage seedcotton yield (Grissom et al., 1955) and no-till soybeans (Sharpe et al., 1988) doublecropped with wheat, when the deep tillage was performed on soils with a hardpan. Although soils in the Brown Loam region generally possess a fragipan, effects of subsoiling on cotton production have not been documented. This study was conducted to determine the influence of four tillage systems on cotton plant population and seedcotton yield on a loess silt loam soil in central Mississippi.

MATERIALS AND METHODS

The study was initiated in 1989 and continued through 1993 on a Calloway silt loam soil (fine-silty, mixed, thermic Glassaquic fragiudalfs) with 0-2% slopes and an initial pH of 6.5. The four tillage systems compared were: [1] Disk (conventional tillage consisting of disk, chisel, disk, hip, do-all, and plant); [2] Hip (rehip old seedbed in spring, do-all and plant); [3] Ro-Till" (in-row subsoil to a depth of 14-16 inches preparing 14-inch-wide seedbed and plant); and [4] No-till (plant directly into standing cotton stubble after chemical burndown of winter vegetation). The experiment was set up as a split-plot in a randomized complete block design with four replications. Each plot consisted of eight rows, spaced 38-inches apart and 50 feet in length. Tillage treatments served as the main plot factor with all systems remaining in the same location for the duration of the study. Half of each plot (4 rows) was cultivated twice during each growing season with a Buffalo"' two-row cultivator to determine if cultivation (subplot factor) influenced population or yield. All tillage operations were performed in the spring.

Glyphosate was applied at 1.0 lb ai/acre 7 to 10 days prior to planting Ro-Till and no-till treatments. Cotton variety 'DES 119' was planted each year at 3-4 seed/ft of row with a no-till planter equipped with ripple coulters, double-disc openers and cast closure wheels. Aldicarb insecticide was applied in-furrow each year at 1.05 lb ai/acre at the time of planting. A tank mix of metolachlor and fluometuron each at

Table 1. Planting and harvest dates for a five year tillage study. Raymond. MS.

Year	Planting Date	Harvest Date
1989	April 28	October 25
1990	May 9	October 11
1991	May 30	October 16
1992	May 4	October 19
1993	May 18	October 6

2.0 lb ai/acre was applied preemergence broadcast on all treatments each year. Fluaziflop (0.188 lb ai/acre) was applied as a spot treatment for rhizome johnsongrass control on an as needed basis. No other herbicide treatments were applied during the growing season. Lime, phosphorus, and potassium were applied to the whole study in the spring of each year according to soil test recommendations. Insecticides were applied as needed based on weekly scouting reports.

Plant populations were determined prior to harvest by counting the number of plants present in 3 linear feet of row in each of the two center rows of each subplot. Plots were defoliated when approximately 60% of bolls were open as determined by visual assessment. Seedcotton yield was determined by harvesting the two center rows in each subplot with a one row spindle picker modified for small plot cotton research. Plant height at harvest was determined in 1991, 1992 and 1993. Plant mapping data collected in 1993 included total number of nodes per plant, total number of fruiting nodes per plant, first fruiting node and length of the taproot. Stalks were shredded in the fall of each year to a height of approximately six inches.

RESULTS AND DISCUSSION

Planting and harvest dates are presented in Table 1. Planting dates ranged from late April to late May, depending on weather patterns. Rainfall by month for the cotton growing season (Table 2) indicates several abnormal rainfall events. In 1989, excess rainfall during the months of June and July occurred with extremely dry weather during August. In 1991, over seventeen inches of rainfall during April resulted in a late planting date. In 1992, less than one inch of rain fell in May and over eight inches in August along with cool temperatures slightly delayed maturity of the crop.

Table 2. Rainfall by month for the cotton growing season, Raymond, MS, 1989-1993.

	Year				
Month	1989	1990	1991	1992	1993
	Rainfall (in)				
April	2.14	2.96	17.54	1.83	4.96
May	5.81	7.25	5.67	0.96	3.26
June	10.37	5.01	1.08	8.19	3.44
July	10.72	1.81	2.97	2.53	5.19
August	0.88	2.37	3.72	8.81	3.94
September	5.23	4.73	4.82	3.14	1.02
October	0.16	1.13	2.02	2.22	4.87

Table 3. Influence of tillage svstem on plant population, Raymond, MS, 1989-1993.

Tillage System	Plant Population (plants/A in thous.)					
	1989	1990	1991	1992	1993	5-Yr. Average
Disk	42.3 a[z]	39.0 a	30.6 ab	45.6 b	38.8 a	39.3 a
Hip	52.2 a	13.0 b	23.3 c	43.4 b	43.7 a	35.1 a
Ro-Till	61.2 a	37.9 a	25.4 bc	51.9 a	36.1 a	42.5 a
No-till	56.2 a	34.9 a	33.1 a	27.6 c	25.4 b	35.5 a
Overall Mean	53.0	31.2	28.1	42.1	36.0	38.1
CV (%)	20.0	29.3	15.8	5.8	15.5	9.8
LSD (0.05)	NS	14.6	7.1	3.9	8.9	NS
Standard Error of Mean	5.3	4.5	2.2	1.2	2.8	1.9

[z] Means in a column followed by the same letter are not significantly different according to Fisher's Protected Least Significance Difference Test (P=0.05).
NS = Not Significant.

With one exception in 1992, no significant interaction between cultivation and tillage occurred, thus, data were averaged over cultivation. No significant population differences occurred among the tillage systems in 1989 (Table 3). The hip system resulted in the lowest plant population among the treatments in 1990 and 1991. There was no significant difference in 1990 among the disk, hip and Ro-Till systems. In 1991 the no-till and disk treatments produced plant populations significantly greater than the hip treatment. The Ro-Till system resulted in significantly greater plant population than the other systems in 1992. The disk and hip systems followed, each with about 43-45,000 plants/acre. The no-till treatment resulted in significantly fewer plants per acre than the other systems in 1992 and 1993. There were no significant differences among the disk, hip and Ro-Till treatments in 1993. There were no significant differences in plant population among the tillage systems for the 5 year average. The trend was for the Ro-Till and disk systems to result in greater plant populations than the hip and no-till treatments.

Seedcotton yields for the tillage systems are presented in Table 4. There was no significant differences in seedcotton yield among the tillage systems in 1989. Ro-Till and disk tillage systems produced significantly greater yield than the hip treatment in 1990 and 1991. Low plant population in the hip treatment may have resulted in the lower yield (Bridge and Miller, 1989). No-till treatment in 1990 yielded similarly to the disk system but was significantly lower than the Ro-Till. Yield in the hip system (1,791 lb/acre) was higher in 1992 than 1991, but was not significantly different from the disk treatment (1,942 lb/acre). The no-till treatment produced the lowest seedcotton yield among the systems in 1992 and 1993. Plant populations in the no-till system were low in 1992 and 1993 and may have resulted in the low seedcotton yields. There was no significant difference in seedcotton yield

Table 4. Influence of tillaae svstem on seedcotton vield. Ravmond. MS, 1989-1993.

Tillage System	Seedcotton Yield (lb/A) 1989	1990	1991	1992	1993	5-Yr. Average
Disk	2,100 a[z]	1,331 ab	2,061 a	1,942 ab	1,685 a	1,823 a
Hip	2.383 a	796 c	1,555 c	1,791 b	1,428 a	1,591 b
Ro-Till	2,538 a	1,441 a	1,867 ab	2,185 a	1,470 a	1,900 a
No-till	2,524 a	1,142 b	1,649 bc	1,354 c	744 b	1,483 b
Overall Mean	2,386	1,177	1,783	1,818	1,331	1,699
CV (%)	20.2	21.5	14.5	14.4	27.3	7.9
LSD (0.05)	NS	216	266	269	374	215
Standard Error of Mean	241.1	126.5	129.2	130.8	181.4	67.1

[z] Means in a column followed by the same letter are not significantly different according to Fisher's Protected Least Significance Difference Test (P=0.051.
NS = Not Significant.

Table 5. Influence of tillaqe system on plant heinht at maturity, Raymond, MS, 1991-1993.

Tillage System	Plant Height (in) 1991	1992	1993	3-Yr. Average
Disk	29.1 a[z]	38.4 c	36.1 a	34.5 a
Hip	31.8 a	39.3 bc	33.9 a	35.0 a
Ro-Till	31.6 a	44.4 a	34.0 a	36.7 a
No-till	29.9 a	41.8 ab	35.4 a	35.7 a
Overall Mean	30.6	41.0	34.9	35.4
CV (%)	11.8	5.0	9.4	6.6
LSD (0.05)	NS	3.3	NS	NS
Standard Error of Mean	1.8	1.0	1.6	1.2

[z] Means in a column followed by the same letter are not significantly different according to Fisher's Protected Least Significance Test (P=0.05).
NS = Not Significant.

among the disk, hip and Ro-Till systems in 1993. The five-year average of seedcotton yield for the tillage systems suggests a trend for the Ro-Till and disk treatments to produce significantly greater seedcotton yields than the hip and no-till systems.

Significant differences in plant height among the treatments occurred only in 1992 (Table 5). Plants grown in the Ro-Till and no-till treatments were taller than those from the hip and disk systems. Extremely dry weather during May 1992 may have resulted in faster drying of the soil in the disk and hip treatments resulting in slower plant growth during this period. The Ro-Till and no-till treatments had ground cover present which may have conserved moisture from earlier rains.

Plant mapping data (not shown) collected during the 1993 growing season indicated no significant differences among the tillage systems for total nodes per plant, total fruiting nodes per plant, first fruiting node and length of the taproot. There was a trend for the Ro-Till and disk treatments to have slightly longer taproots. The subsoil begins about 7-8 inches deep and tillage from the Ro-Till and the chisel operation in the disk treatment may have fractured the upper layer of the subsoil resulting in less restriction for taproot growth in these treatments.

A significant (P < 0.051 treatment x cultivation interaction (data not shown) occurred for both plant population and seedcotton yield in 1992. Fewer plants per acre were present in the cultivated plots of the disk, hip and Ro-Till systems as compared to the same plots not cultivated. About, 6,000 more plants per acre resulted in the cultivated no-till plot as compared to the no-till plot not cultivated. The result was greater seedcotton yield (about 200 lb/a) in the cultivated no-till plot when compared to the no-till plot not cultivated. Visual observation indicated more weeds were present at harvest in the no-till non-cultivated plot than the cultivated no-till plot. The result of cultivating no-till plots in this study most likely produced increased yield by controlling weeds. Plant populations have been shown to be variable from year to year in no-till experiments (Bloodworth and Johnson, 1992) and occasionally lower in cultivated versus not cultivated plots (Johnson et al., 1992).

SUMMARY

The Ro-Till and disk systems resulted in highest seedcotton yield in the 5 year study. The hip and no-till systems each resulted in the lowest plant populations in two out of five years of the study. There were no differences in plant populations among the four treatments for the 5 year average. Ro-Till and no-till systems produced taller plants in 1992. No significant differences were indicated for plant mapping parameters in 1993. Cultivation did not influence yield or plant population except in the no-till system in 1992 when cultivating resulted in slightly more plants per acre and increased yield.

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