# LONG TERM REDUCED TILLAGE SYSTEM EFFECTS ON COTTON GROWTH AND YIELD

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## Abstract

One pass reduced tillage stale seedbed preparation systems are essential for cotton profitability, especially with increased energy costs. A six year (2003-2008) study was conducted on a Leeper silty clay loam soil to evaluate one-pass reduced tillage systems in comparison to no-till on land with 0.2% slope. No-till had less mid-season plant height than the early spring applied Prepmaster® bed system, fall bed-roller, fall Paratill® (10-12 inch depth under-row tillage) followed by bed-roller and alternating years of fall bed-roller and fall Paratill plus bed-roller in 2003, 2004 and 2005 with no differences in 2007 and 2008. Except for no-till, tillage systems showed no yield differences all years. No-till yield was lower than all other tillage systems in 2003-2006 with no differences in 2007 and 2008. Tillage system did not effect on number of nodes per plant in early season. Raised beds showed the most consistent high yields across years with no yield benefit from the fall deep under-row tillage.

## Introduction

Maintaining profitability is essential for survival in cotton production. Reducing the number of tillage trips across the field improves profitability especially with higher energy and equipment costs. Reducing tillage trips in cotton production from 7 in the conventional system to 3 increased cotton yield and net returns on a silt loam soil (Buehring et al. 2004). The whole farm enterprise analysis indicated fall disk + Paratill-bed-roller system followed by a doall (row conditioner) at planting, and ridge-till followed by a doall at planting in a 50% corn-cotton rotation system showed similar net returns. Both of these systems showed 40 and 28% higher net return than conventional tillage for Northeast Mississippi and Mississippi delta farms, respectively.

However, yield response to tillage systems has shown variability. Bauer et al. (2005) reported conservation tillage produced higher yield than conventional tillage. Conventional tillage on a Leeper silty clay loam soil in 38 inch rows produced higher yield than no-till but equal to minimum tillage (Jones et al. 1996). Research on a Leeper fine sandy loam soil indicated no yield advantage for the fall Paratill (under-row tillage) plus bed-roller over fall bed-roller alone (Buehring et al. 2005). Long term studies on an Orelia sandy clay loam soil indicated no-till cotton yields were 15% lower than conventional tillage (Matocha et al. 2005). This was in contrast to a Victoria clay which showed no-till cotton produced yield equal to both minimum tillage and conventional tillage.

A long term study is being conducted to determine whether no-till cotton on old beds or a one-pass raised bed land preparation stale seedbed system applied in the spring or in the fall in a controlled traffic system maintained yield equivalent to a fall, deep under-row tillage with a raised bed stale seedbed system or alternating years of raised beds with and without under-row tillage.

## Materials and Methods

The study was conducted as a randomized complete block design with 4 replications. Plot size was 4 rows (38-inch) by 500 ft long. All tillage treatments (fall bed-roller, fall Paratill + bed roller) except the Prepmaster were applied in January 2003 (due to wet fall in 2002) and October 2003, 2005, 2006 and November 2004, 2007. The Prepmaster treatment was applied late March or early April of each year. Prepmaster is a pre-plant herbicide incorporator manufactured by Bigham Brothers, Lubbock, Texas. This implement was equipped with 16-inch sweeps positioned on the center of the bed, a small 9-inch wide buster sweep (reshape bed), a rolling cutter bar, a rolling basket, and smooth metal roller. This implement was operated at 6 to 7 mph and created a smooth wide surface bed for planting at a uniform depth with a bed height of 4 to 6 inches. The implement can be used just prior to planting or 2 to 3 weeks before planting. The Paratill implement has an offset shank that lifts the soil under the row and it was operated at a depth of 10 to 12 inches.

Recommended agronomic practices were used for a 2 bale cotton yield goal. Delta and Pineland Company DP215BR variety was planted on all plots in 2003 through 2006 and DP143B2RF was used in 2007 and 2008. Planting dates ranged from late April to mid-May. Potassium and phosphorus fertilizers were applied based on soil test recommendation. Nitrogen fertilizer as a UAN (32%N) solution was applied at 90 lb/acre with a coulter-knife system that placed the fertilizer approximately 8 inches from the row and 2 inches deep. The nitrogen fertilizer was applied to cotton in the pinhead square stage of growth. Pentia (mepiquat pentaborate) applications were made as needed to control rank cotton growth.

The study was defoliated in September of each year when cotton was in the 4 nodes above cracked boll stage of maturity. The center 2 rows of the study were harvested in mid to late September with a 2-row spindle picker equipped for plot harvest. Grab samples were pulled from the seed cotton samples of each plot. The seed cotton samples were ginned with an 8-saw laboratory gin (no dryer, seed cotton cleaners, or lint cleaners) to determine percent lint turnout. Data collected were plant stands 4 weeks after planting (WAP); mid-season plant height and nodes/plant 11 WAP; seed cotton yield; percent lint turnout; and lint yield. The data were subjected to SAS mixed procedure analysis with year as main plot and tillage treatment as subplots (Littell et al. 1996). Means were separated using Fisher's Protected LSD calculated at the 5% significance level.

## Results and Discussion

The environmental growing seasons were highly variable all years but lint yields averaged about 1100 lb/acre. The old beds formed in fall of 2001 in the continuous no-till treatment were 1 to 1.5 inches tall in 2003-2008. End of the growing season bed height measurements indicated 1 to 1.5 inch height for no-till and 4 to 6 inch height for all other raised bed systems (data not shown). There was a year by tillage interaction for plant population, mid-season plant heights, and total nodes per plant and lint yield.

Tillage system plant populations 4 WAP, ranged from 19,800 plants/acre in 2003 to 60,500/acre in 2008 (Table 1). The tillage system mean populations ranged from 23,400 plants/acre in 2003 to 57,500/acre in 2008. No-till populations were only lower than the fall Paratill + bed-roller in 2003 and fall Paratill + bed-roller and Prepmaster in 2006 and all tillage systems in 2008. The lower no-till populations in 2003, 2006 and 2008 were related to poor surface drainage (no beds) during wet soil conditions that existed during seedling emergence. Prepmaster had lower populations in 2007 than fall Paratill + bed-roller, no-till and fall bed-roller Fb fall Paratill + bed-roller. In 2004, 2005 and 2007 plant populations were within 5,000 plants/acre for all tillage systems. Except for no-till in 2003, all plant populations were above the critical level where plant population may have reduced yield. Reports (Bednarz et al., 2005; Pettigrew and Johnson, 2005; Siebert and Stuart, 2006; and Siebert et al., 2006) indicated yield reductions can occur with populations from 14,000 to 24,000 plants/acre.

Table 1. Plant population 4 weeks after planting as influenced by tillage systems in 2003-2008, Verona, MS.

| | Plants/acre X 1000 | | | | | |
|---|---|---|---|---|---|---|
| Tillage System | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| Late April Prepmaster | 24.1 | 43.8 | 55.1 | 40.2 | 33.4 | 62.3 |
| Fall Bed-Roller | 24.2 | 46.1 | 52.0 | 35.4 | 36.7 | 56.4 |
| Fall Paratill + Bed-Roller | 26.1 | 45.0 | 50,8 | 38.3 | 42.4 | 60.2 |
| No-Till | 19.8 | 44.4 | 50.0 | 32.2 | 42.8 | 47.9 |
| Fall Bed-Roller ('03,'05,'07) Fb Fall Paratill + Bed ('04,'06,'08) | 22.8 | 42.1 | 55.1 | 35.9 | 40.2 | 60.5 |
| Mean | 23.4 | 44.3 | 52.6 | 36.4 | 39.1 | 57.5 |
| Within or across year $LSD_{0.05}$ = 5.5 | | | | | | |

Tillage systems mean heights 11 WAP ranged from 26 inches in 2003 to 44 inches in 2004 (Table 3). The no-till tillage system had shorter plant heights than all other tillage systems in 2003, 2004 and 2005 with no differences in 2006 and 2007. In 2008 Prepmaster plant height was less than fall Paratill + bed-roller with no difference among the other tillage systems.

Table 2. Plant heights 11 weeks after planting as influenced by tillage systems in 2003-2008, Verona, MS.

| | Plant Height (Inches) | | | | | |
|---|---|---|---|---|---|---|
| Tillage System | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| Late April Prepmaster | 26 | 44 | 33 | 21 | 30 | 21 |
| Fall Bed-Roller | 27 | 45 | 33 | 22 | 33 | 23 |
| Fall Paratill + Bed-Roller | 26 | 45 | 34 | 23 | 32 | 26 |
| No-Till | 22 | 38 | 28 | 22 | 33 | 24 |
| Fall Bed-Roller (’03,’05,’07) Fb Fall Paratill + Bed-Roller (’04,’06,’08) | 27 | 46 | 37 | 22 | 33 | 26 |
| Mean | 26 | 44 | 32 | 22 | 32 | 24 |
| Within or across year $LSD_{0.05}$ = 3 | | | | | | |

The number of nodes 11 WAP indicated no differences in 2003 and 2005 (Table 3). Prepmaster in 2006 and 2008 had fewer nodes than the fall Paratill + bed-roller. In 2004, nodes per plant for no-till were similar to Prepmaster, but fewer than all other treatments with no differences among the other tillage systems. Prepmaster had fewer nodes than the fall Paratill + bed-roller in 2006 with no differences among the other tillage systems. In 2007 and 2008 Prepmaster had fewer nodes than the fall bed-roller Fb Paratill + bed-roller with no difference among other tillage systems. In 2007 and 2008 all tillage systems had more nodes per plant than 2003, 2004, 2005 and 2006.

Table 3. Total nodes 11 weeks after planting as influenced by tillage system in 2003-2008, Verona, MS.

| | Nodes per Plant | | | | | |
|---|---|---|---|---|---|---|
| Tillage System | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| Late April Prepmaster | 11.1 | 11.8 | 13.2 | 11.3 | 13.7 | 13.9 |
| Fall Bed-Roller | 11.5 | 12.2 | 13.6 | 12.3 | 14.6 | 14.9 |
| Fall Paratill + Bed-Roller | 11.4 | 12.0 | 13.1 | 13.0 | 14.8 | 16.2 |
| No-Till | 10.6 | 10.5 | 12.5 | 11.8 | 14.9 | 16.3 |
| Fall Bed-Roller (’03,’05,’07) Fb Fall Paratill + Bed-Roller (’04,’06,’08) | 11.5 | 12.1 | 13.5 | 12.4 | 15.5 | 16.0 |
| Mean | 11.2 | 11.7 | 13.2 | 12.2 | 14.7 | 15.5 |
| Within year $LSD_{0.05}$ = 1.4 Across year $LSD_{0.05}$ = 1.0 | | | | | | |

Within each year the Prepmaster, fall bed-roller, fall Paratill + bed-roller every year and alternating years with the fall bed-roller system showed no lint yield differences (Table 4). However, the no-till system yield was lower than all other tillage systems in 2003, 2004, 2005 and 2006 with no difference among tillage systems in 2007 and 2008. These results indicated deep tillage is not necessary on these soils for maximum yield. But a raised bed system

applied in the fall or spring showed the most consistent yield across years on soils with slopes 0.2% or less. Averaged over years, the raised bed systems showed 12% higher lint yield than no-till.

Table 4. Six year (2003-2008) lint yield response to tillage system on a Leeper silty clay loam soil, Verona, MS.

| | Lint Yield lb/acre | | | | | |
|---|---|---|---|---|---|---|
| Tillage System | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
| Late April Prepmaster | 1149 | 1144 | 1072 | 1020 | 1105 | 1076 |
| Fall Bed-Roller | 1102 | 1134 | 1047 | 1060 | 1076 | 1064 |
| Fall Paratill + Bed-Roller | 1099 | 1152 | 1043 | 1071 | 1128 | 1063 |
| No-Till | 880 | 946 | 890 | 704 | 1160 | 1125 |
| Fall Bed-Roller ('03,'05,'07) Fb Fall Paratill + Bed-Roller ('04,'06,'08) | 1154 | 1122 | 1129 | 1126 | 1154 | 1165 |
| Mean | 1077 | 1100 | 1036 | 996 | 1125 | 1099 |
| Within year $LSD_{0.05}$ = 122 Across year $LSD_{0.05}$=136 | | | | | | |

Lint turnout showed differences among tillage systems and years with no interactions (data not shown). Averaged over years, there were only minor differences among tillage systems and ranged from 41.3% to 42.4%. Prepmaster and the fall bed-roller had the highest lint turnout of 42.0% and 42.7%, respectively. Lint turnout ranged from a low of 38.4% in 2004 to a high of 44.8% in 2008.

## Conclusion

The fall or spring raised bed systems are essential for consistent high yields on a Leeper silty clay soil with a 0.2% slope. Paratill (under-row deep tillage) done annually or every other year showed no yield increase. The no-till system, averaged over years, had 12% lower yield than the raised bed systems.

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