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REDUCING RECOMPACTION WITH AUTOMATIC STEERING

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Abstract

Producers in the Coastal Plain of the southeastern U.S. manage soil compaction in conservation tillage systems by strip-tillage prior to planting. However, planting directly over the loosened zone of soil can be difficult in high-residue conservation tillage systems where cover crop production is maximized. Tractors with automatic steering capability could assist with adjacent placement of deep tillage and planting operations, but little is known about the accuracy necessary to maximize rooting development, reduce succeeding soil compaction, and optimize crop yield. An experiment was conducted in south-central Alabama to evaluate the distance deep tillage can be from the cotton row and still affect cotton growth and soil loosening. Results suggest that if the deep tillage exceeds two inches away from the cotton row, cotton yields are reduced and soil surface compaction is increased.

Introduction

High residue conservation tillage systems are becoming an important tool for farmers who want to conserve soil moisture and increase soil organic matter on the sandy Costal Plain soils of the southeastern U.S. However, soil compaction in these soils can reduce crop yields. This problem can be rectified via annual deep tillage (e.g. strip-tillage or in-row subsoiling). Deep tillage disrupts compacted soil profiles in a narrow zone under the row, allowing roots to proliferate downward to obtain adequate soil moisture (Raper, 2005).

In the high-residue conservation tillage systems of the Coastal Plain soils, deep tillage is commonly implemented between the termination of the cover crop and the planting operation. During planting, producers attempt to plant directly over the loosened zone created by deep tillage. Planting directly in the middle of the loosened zone can be difficult, especially with strip-tillage systems that do little surface disruption.

New technologies such as auto-steer tractors using GPS satellite information may be beneficial in these high residue conservation tillage systems by allowing producers the accuracy to control traffic and tillage patterns. However, the cost of auto-steer technology can be prohibitive and escalates rapidly with increased precision of the steering system. Furthermore, little is known about how the precision of these systems affects soil compaction or crop yield. Therefore, an experiment on a Coastal Plain soil was conducted to determine the distance between cotton rows and strip-tillage zones that would maximize crop production and minimize soil compaction.

Methods and Materials

In the fall of 2002, a field with a pronounced soil hardpan was selected at the E.V. Smith Research Station in Shorter, Al. The soil type is a Compass loamy sand (Coarse-loamy, siliceous, subactive, thermic Plinthic Paleudults) with less than 2% slope. The field was planted with a rye (*Secale cereale* L.) cover crop in the fall of 2002 and all subsequent years.

In the spring of 2003, deep tillage was implemented with a JD 8300 tractor equipped with a Trimble AgGPS Autopilot system which has reported automatic steering accuracy of ± 1 in. The field (415 ft long) was divided parallel to the rows into twelve (30 ft) plots with eleven (5 ft) borders. The same tractor was used to plant the cotton at a slight angle to the deep tillage rows. At one end of the field, the cotton was planted directly over the deep tillage zone and at the other end of the field, the cotton was planted midway between the deep tillage zones. This setup resulted in twelve plots with varying ranges of distances between the cotton row and the deep tillage zone (row proximity distance) enabling the evaluation of row proximity on cotton yield and soil compaction.

The study was designed to compare the effect of row proximity of strip-tillage on four different conservation tillage systems and was conducted for three years. These implements included a Kelley Manufacturing Company's (Tifton, GA) Rip/Strip in-row subsoiler, a Bigham Brothers' (Lubbock, TX) Paratill® bentleg subsoiler, a Worksaver (Litchfield, IL) Terra-Max I® bentleg subsoiler, and a no-deep tillage treatment (control). Each tillage system was replicated four times and was present in all 12 plots with varying row proximity distances (192 plots). The plots were 4 rows wide with 40 in. row spacings.

Seed cotton yield and cone index were used to evaluate the tillage systems. A JD 9920 cotton picker was used to bag the center two rows of every plot. Relative seed cotton yield was calculated by dividing the cotton yield for each strip-tillage treatment by the cotton yield obtained from the nearby no-till treatment. This procedure should allow comparisons to be made between the various row proximities along the entire length of the field. Soil strength measurements were obtained with the multiple-probe soil cone penetrometer system (Raper et al., 1999) in the fall of 2005 following cotton harvest. This machine acquired three sets of soil strength measurements in the row from which cone index values were calculated (ASAE Standards, 2004a; ASAE Standards, 2004b).

The experimental design was a randomized complete block with four conservation tillage systems as treatments. Statistical analyses were performed at each of the twelve row proximity distances with an appropriate ANOVA model using SAS. A predetermined significance level of $P \leq 0.10$ was selected and Fisher's least-significant-difference test (LSD) was used for means separation.

Results and Discussion

In the data colleted from 2003 and 2005 there was very little statistical difference in relative seed cotton yield between the three deep tillage implements at any one row proximity distance. However, in 2004 the relative seed cotton yield was found to be greater for the KMC subsoiler compared to the Terramax at four of the twelve row proximity distances. Additionally the three-year average relative seed cotton yield was significantly greater for the KMC subsoiler compared to the Paratill or the Terramax at seven of the twelve row proximity distances (fig. 1).

Averaged across all three years of the experiment, the row proximity distance also had an effect on relative seed cotton yield (fig. 1). Three regions of similar relative seed cotton yields (0.25 - 2 in, 3.75 - 9 in, and 10.75 - 19.5 in) were found by examining the data. The greatest relative seed cotton yield was determined to be in the 0.25 - 2 in range at 144 % of no-tillage cotton yield. Average relative seed cotton yields in the 3.75 - 9 in range were reduced to 128 % of no-tillage cotton yield. Average relative seed cotton yields were decreased even more in the 10.75 - 19.5 in. range to 114 % of no-tillage cotton yield.

To simplify discussion, only cone index measurements in the shallowest depth range will be discussed. Soil cone index measurements taken in the row in the 0 - 2 in depth range were affected by both tillage system and row proximity distance (fig. 2). No-tillage had significantly greater soil strength than all other deep tillage treatments with row proximities of 0 - 7.25 in. As row proximity increased from 10.75 - 19.5 in, soil strength values for deep tillage treatments increased to values similar to the no-tillage treatment.

Conclusions

1. Relative seed cotton yield decreased 16 % when the distance between the row and the subsoiled zones exceeded 2 in. When the row proximity exceeded 9 in, relative seed cotton yield decreased by 30%.
2. Soil strength was significantly increased in the row when the distance between the row and the subsoiled zone exceeded 7.25 in.
3. To maximize crop yields and minimize soil compaction in the row, the subsoiled zone should be kept within 2 in of the row. Necessary precision of ± 2 in would be necessary from an automatic-steered tractor to obtain these results.

Disclaimer

The use of trade names or company names does not imply endorsement by USDA-ARS.

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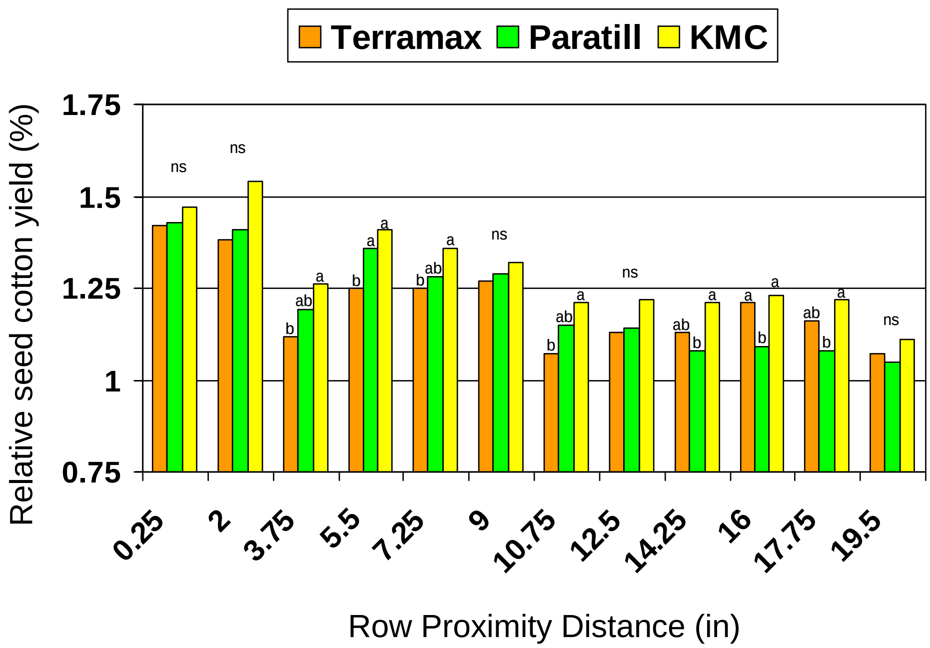

Figure 1. Relative seed cotton yield averaged for all years (2003-2005). Letters indicate statistical significance ($LSD_{0.10}$).

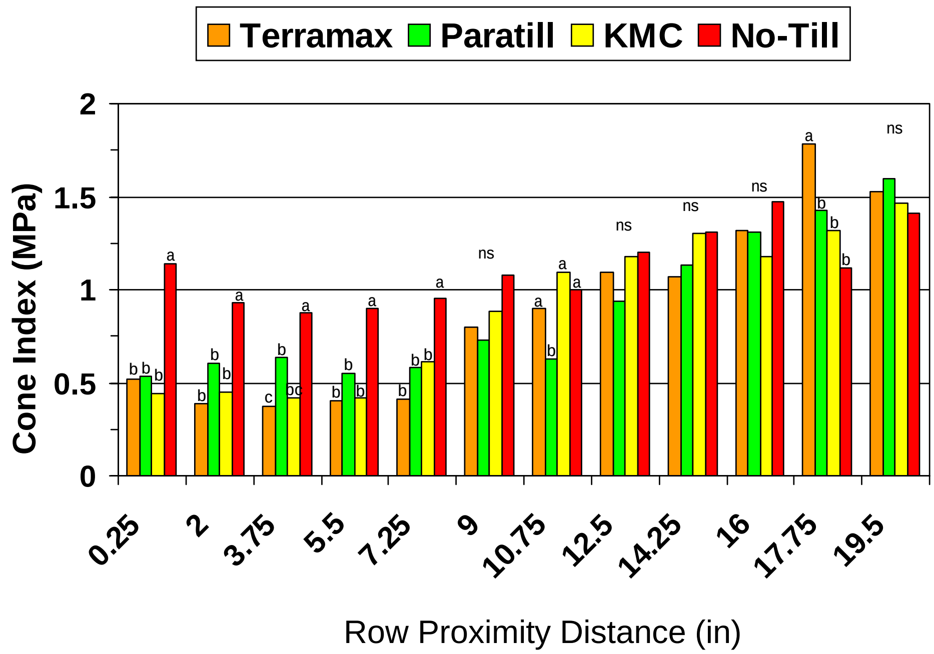

Figure 2. Cone index (in-row position) at the 0 to 2 in depth. Letters indicate statistical significance ($LSD_{0.10}$).