BENEFITS OF ALTERNATING THE SHANK LOCATION ON A BENT-LEG STRIP-TILL

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Abstract

This study was initiated in 2004 at the E.V. Smith Agricultural Research Center, near Shorter, in central Alabama. A cotton (*Gossypium hirsutum*) –corn (*Zea mays*) rotation was established, with both phases of the rotation present each year. Two tillage treatments were studied: 1) bent-leg strip-till with the shanks remaining in the same position every year, and 2) bent-leg strip-till with the shanks alternating locations every other year. Spacing between shanks was 36", same as the row spacing. Alternating the location of the shank consisted of inverting the direction the bent-legs faced from one year to the next. The objective was to determine if, by alternating the shank orientation, a larger volume of soil was loosened, thus improving yields. The alternating shank location produced greater cotton yield both years. Seedcotton yields for the alternating shank location treatment were 7 % greater (3,012 vs. 2,809 lb/ac) in 2005, and 32 % greater (1,978 vs. 1,503 lb/ac) in 2006. Corn yields showed no difference between tillage treatments. Differences in soil moisture measured during both growing seasons were small. Soil penetration resistance data collected at the end of both seasons suggest that the alternating shank location treatment loosens a greater volume of soil. These data might suggest that cotton benefits most from this non-inversion tillage operation.

Introduction

Climatic conditions of relatively high rainfall and temperatures in the southeastern U.S. contribute to soils with low organic matter content. Further, conventional soil management practices promote organic carbon loss. For these reasons, these soils tend to have either natural or anthropogenic compacted soil layers. Root development is often restricted by soil compaction, thus reducing yields (Alblas et al., 1994; Schuler and Lowery, 1984; Schwab et al., 2002). Cotton can be somewhat sensitive to soil compaction. A properly developed root system is necessary for adequate nutrient and water uptake. Hard pan layers reduce the downward flow of water and limit root growth. Soil organic matter improves soil physical properties (Arriaga and Lowery, 2003; Tester, 1990; Warren and Fonteno. 1993).

Surface soil disturbances, such as conventional tillage, must be kept to a minimum to promote soil organic matter accumulation. Nonetheless, the presence of compacted soil layers creates the need for some form of tillage (Raper and Bergtold, 2007). Non-inversion tillage operations can aid in creating looser soil conditions while minimizing surface soils disruption. A Paratill^{tm} is a type of bent-leg non-inversion tillage implement commonly used on Coastal Plain soils of the southeastern U.S. (Raper, 2005). Conservation tillage operations with a Paratill^{tm} are usually conducted with the shanks placed in the same location year after year, disrupting the same volume of soil. Moving the location of the shanks on the toolbar so they are inverted from the previous year's location can potentially increase the volume of disrupted soil below ground. This can create more favorable conditions for soil water redistribution into the root zone, while increasing soil rooting volume. The objective of this on-going work is to determine if alternating the location of the shanks on a Paratill^{TM} benefits crop productivity by enhancing below ground soil disruption.

Materials and Methods

The study is being conducted at the Field Crops Unit of the E.V. Smith Research Center near Shorter, Ala. on a Compass loamy sand (coarse-loamy, siliceous, subactive, thermic Plinthic Paleudults). The experiment was established in Spring 2004, but due to the nature of the treatments, data collection did not start until the 2005 growing season. Two tillage treatments, same shank location and alternating every other year, are being studied (Fig. 1). A corn-cotton rotation was established with both crops present each year.

Soil penetration resistance data as cone index were collected in the Fall with a multi-probe cone penetrometer consisting of five rods pushed into the ground simultaneously (Raper et al., 1999). The center rod was placed over the row, the outer two rods in the center of the row middles, and the remaining rods half way between the row and middles. Soil moisture data were collected using capacitance soil moisture probes inserted vertically in the row, at a depth of 5 cm from the surface, thus measuring from 5- to 25-cm of depth.

Data were analyzed using the generalized linear model procedure in SAS (Statistical Analysis Software, ver. 9.1). A significance level of 10 % was established a priori.

Results and Discussion

Yields

Corn yields were not affected by alternating the shank location. However, alternating the location of the shank did increase seed cotton yields 7 ($p = 0.021$) and 32 % ($p = 0.104$) for 2005 and 2006, respectively. No significant

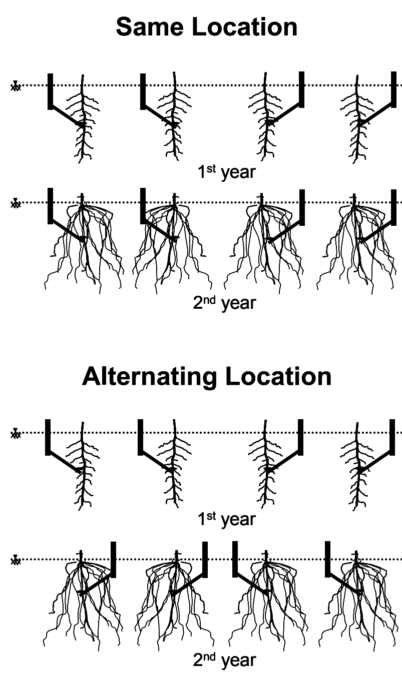

Figure 1. Shank orientation on the toolbar of the Paratill^{tm}. The treatment with the shanks on the same orientation each year is shown on top. Orientation of the shanks will alternate each year for the other treatment.

differences ($p = 0.144$) were observed during the drought year of 2007. Corn roots are probably less susceptible to soil compaction, whereas cotton plants tend to experience a condition called “J-rooting” when soil resistance is high. Overall yields for the 2006 season were suppressed due to a late season drought. An extreme drought during the 2007 season affected yields significantly.

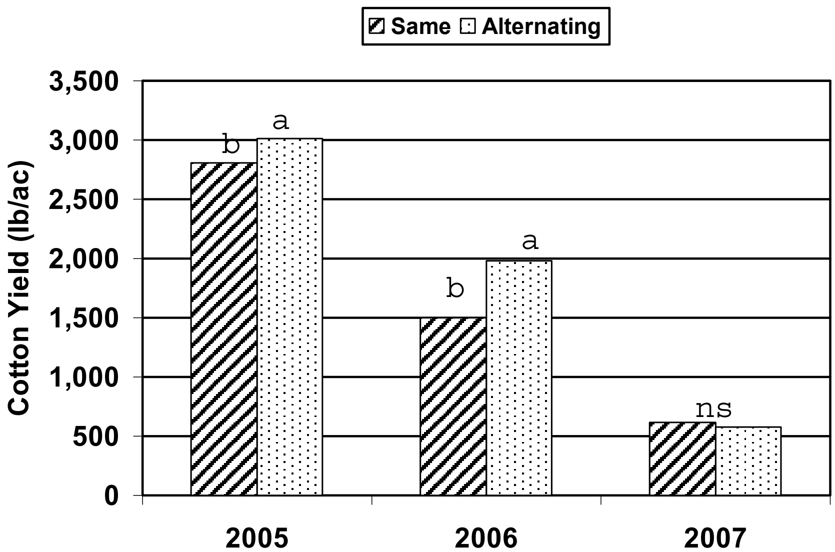

Figure 2. Cotton seed yields were significantly increased by alternating the shank orientation in 2005 and 2006. Yield were generally lower in 2006 due to a late season drought and an extreme drought in 2007.

Soil Penetration Resistance

Cone index values for 2006 tended to be lower in the rooting zone for the alternating shank placement compared to when the shank location was the same year-after-year (Figure 3). Average cone index values were significantly (p = 0.039) lower for the alternating location versus the same shank placement treatment. Cone index values greater than 2 MPa can impair root development (Taylor and Gardner, 1963).

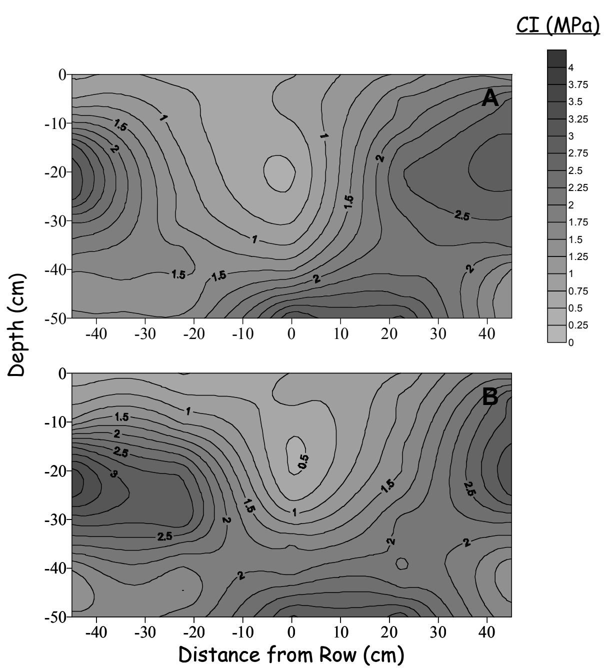

Figure 3. Soil penetration resistance profile for the same shank location (A) and alternating shank location (B) tillage treatments in the fall of 2006. The 0-cm value on the x-axis of the contour plots represents the row.

Soil Moisture

Soil water content was slightly greater for the same location shank treatment during most of the 2005 growing season in the cotton crop. However, the opposite was true during the 2006 season. Differences in soil moisture for corn during the same years were minimal.

Conclusions

Alternating the shank every other year on a Paratill^{tm} increased cotton yields significantly. The alternating shank treatment seemed to disrupt the soil more efficiently creating more favorable conditions for roots to grow. There were no differences in corn yields. Corn roots appear to tolerate soil compaction more than cotton. Long term use of this practice can have a greater impact on soil strength.

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References

Alblas, J., F. Wanink, J. van den Akker, and H. M. G. van der Werf. 1994. Impact of Traffic-Induced Compaction of Sandy Soils on the Yield of Silage Maize in the Netherlands. Soil & Tillage Research 29(2-3):157-165.

Arriaga, F.J., and B. Lowery. 2003. Soil Physical Properties and Crop Productivity of an Eroded Soil Amended with Cattle Manure. Soil Science 168(12):888-899.

Raper, R.L., B.H. Washington, and J.D. Jarrell. 1999. A Tractor-Mounted Multiple-Probe Soil Cone Penetrometer. Applied Engineering in Agriculture 15(4):287-290.

Raper, R.L. 2005. Force Requirements and Soil Disruption of Straight and Bentleg Subsoilers for Conservation Tillage Systems. Applied Engineering in Agriculture 21(5):787–794.

Raper R.L. and J. S. Bergtold. 2007. In-Row Subsoiling: a Review and Suggestions for Reducing Cost of this Conservation Tillage Operation. Applied Engineering in Agriculture 23(4):463-471.

Schuler, R. T., and B. Lowery. 1984. Subsoil Compaction Effect on Corn Production with Two Soil Types. ASAE Paper No. 841032. St. Joseph, Mich.: ASAE.

Schwab, E. B., D. W. Reeves, C. H. Burmester, and R. L. Raper. 2002. Conservation Tillage Systems for Cotton Grown on a Silt Loam Soil in the Tennessee Valley. Soil Science Society of America Journal 66(2):569-577.

Taylor, H.M., and H.R. Gardner. 1963. Penetration of Cotton Seedling Taproots as Influenced by Bulk Density, Moisture Content, and Strength of Soil. Soil Science 96(3):153-156.

Tester, C. F. 1990. Organic Amendment Effects on Physical and Chemical Properties of a Sandy Soil. Soil Science Society of America Journal 54:827–831.

Warren, S. L., and W. C. Fonteno. 1993. Changes in Physical and Chemical Properties of a Loamy Sand Soil When Amended with Composted Poultry Litter. Journal of Environmental Horticulture 11:186–190.