A COMPARISON OF SLIT TILLAGE AND SUBSOILING IN A SUBSURFACE HARDPAN SOIL

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ABSTRACT

Sorghum was grown for four years (1986 to 1989) on plots that were slit tilled, subsoiled, and no tilled. Corn was grown for three years (1990 to 1992) following the tillage to access its residual effects. Draft was measured for slit-till and subsoil implements the first year of the study. Pits were dug each year to assess root growth. Soil strength was measured the last three years. Draft requirements for the slit tillage implement was **75%** of that for a comparable subsoiler. The slit tillage implement disrupted the soil to the top of the pan and cut a eighth of an inch slit through the pan. The subsoiler disrupted the soil to the bottom of the subsoil pan. When the plots were tilled, slit tilled and subsoiled treatments both outyielded no tillage. Sorghum yields for slit tillage were slightly higher than subsoiling. After tillage ceased, subsoiled treatments outyielded no tillage. Yield for the slit tillage treatment was about the same as for no tillage. Soil strength readings showed that more of the profile was disrupted below the row for subsoiled treatments than for slit-tillage treatments. Few slits could be found in the pit walls after three years. With lower energy requirements than subsoiling and comparable yield, slit tillage has promise for this southeastern Coastal Plain soil as long as regularly scheduled tillage is required. Slit tillage management warrants further investigation.

INTRODUCTION

Reconsolidation of subsurface hardpans in southeastern Coastal Plain soils (Threadgill, 1982; Busscher, et al., 1986) forces producers to annually disrupt the profile to provide a zone of low strength for root growth. In-row subsoiling has been the norm for deep disruption for a number of years. Unlike deep chiseling, in-row subsoiling shatters only a portion of the profile. Thinner subsoil shanks disrupt smaller zones within the profile (Busscher *et al.,* 1988) and use less energy (Karlen et al., 1991). The major advantage of any subsoiling tool is to penetrate the hardpan and encourage root growth below it. Unfortunately, deep profile disruption techniques use substantial amounts of energy (Elkins and Hendrick, 1983; Garner, et al., 1987). It would be beneficial to develop less expensive, less energy intensive practices which disrupt subsoil pans and/or promote root growth.

Slit tillage encourages root penetration of hardpans by cutting macropore size slits through a pan. The development of these slits is cheaper than conventional subsoiling for two reasons. First, the energy required to cut the slits is less than that needed to disrupt the profile or even a thin segment of it. Second, annual deep tillage may not be necessary since infilling of slits with roots keeps them open for more than one year in the Gulf Coastal Plain (Elkins and Hendrick, 1983).

Slit tillage has been effective in soils with shallow traffic or tillage pans of 8 in or less. The objective of this study was to compare slit tillage to in-row subsoiling and no tillage on soils with a deep (8 to 16 in) compacted horizon during the years that the tillage was being performed and for three years following tillage.

Methods

In 1986 plots were established at the Coastal Plains Research Center in Florence SC. Treatments included subsoiling, slit tillage, and no tillage. Plots were arranged in randomized complete blocks with four replicates. Each plot had six 30-in wide rows that were 60-ft long. Data was collected from the center two rows of each plot. The soil was a Norfolk loamy sand (typic Kandiudult) with a hardpan below the plow layer. The soil at the depth of the pan (8 to 16 in) varied from a loamy sand E horizon to a transitional layer grading to a sandy clay loam Bt throughout the field.

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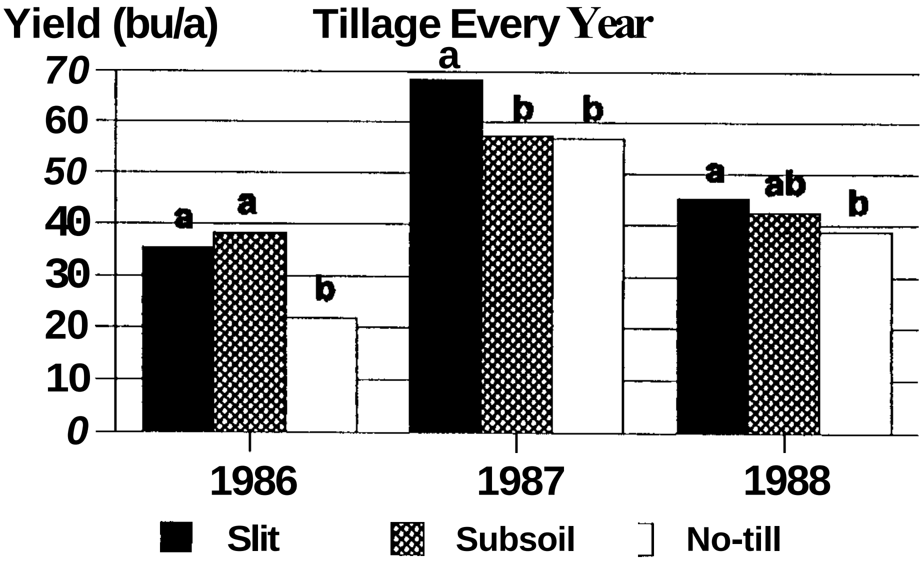
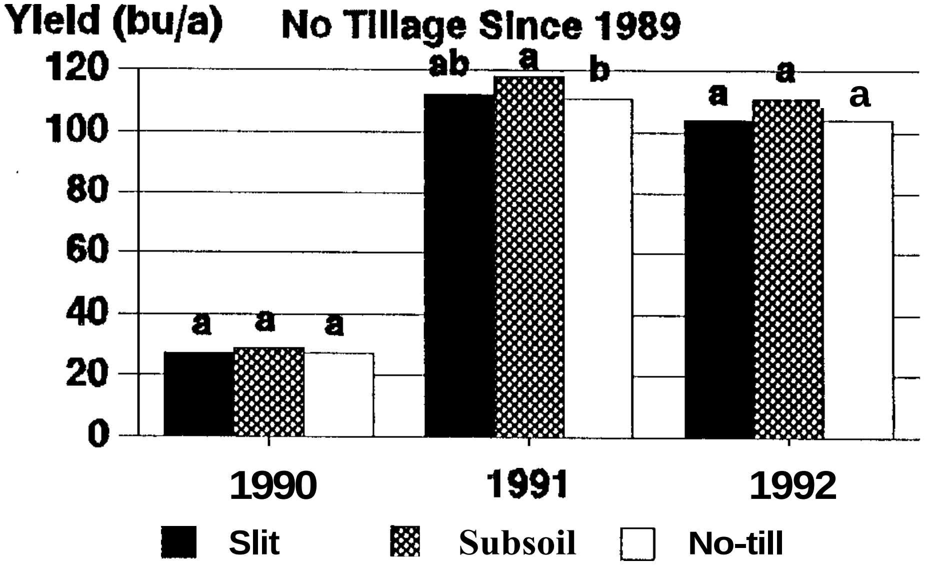
Figure 1. Sorghum Yield



Means with the same letter are not significantly different within year using the lsd test.

Figure 2. Corn Yield



Means with the same letter are not significantly different within year using the lsd test.

There was no surface tillage during any of the study. Winter weeds were controlled with glyphosate or with paraquat and alachlor. Grain sorghum (cv. Savannah 5) was grown in the plots from 1986 through 1989. Corn (cv Pioneer 3165) was grown in 1990, 1991, and 1992. Preplant fertilizer was broadcast at a rate of 50-22-41 lb/a N-P-K for the sorghum and at a rate of 0-16-89 lbla N-P-K for the corn.

The tillage treatments were imposed on the plots with (i) a forward angled shank, disrupting the soil to a depth of 12 in with a knife blade welded to the foot of it to cut a 4-in deep one-eighth-inch wide slit through the pan, the slit tillage treatment, (ii) a longer, forward-angled, nonparabolic subsoil shank, disrupting the soil to a depth of 16 in, the subsoiled treatment, or (iii) no deep tillage. Tillage was moved into mid and quarter row positions from year to year to provide a uniform pattern of slits below the rows.

Paraquat (used with a shielded sprayer) and atrazine were used to control weed growth throughout the growing season. Urea-ammonium nitrate was applied at a rate of 60 lbs N/acre for the sorghum between 1986 and 1989 and at a rate of 120 lbs N/acre for the corn between 1990 and 1992.

Pits were dug each year at the end of selected plots. Pits were used to observe and photograph root growth through the slits and to evaluate root growth through the hardpans.

Soil strength was measured with a 0.5-in, cone-tipped penetrometer (Carter, 1967). Strength was measured across two rows at 3.75-in intervals to a depth of 2 ft and averaged to give readings for a single row.

To obtain draft requirements, a two row parabolic subsoil shank and a similar shorter shank with the slit-tillage knife attached to the bottom of it were hitched to a John Deere 3020 tractor equipped with a dynamometer (Garner and Dodd. (1985). Draft measurements were made approximately 150 ft from the experimental site on the same soil type.

Yield was obtained with a small plot combine and corrected to 15% moisture for the sorghum and 15.5% for the corn. Data were analyzed using GLM and ANOVA in SAS (SAS Institute, 1990).

Results and Discussion

The Norfolk soil had a gray-brown loamy sand surface horizon, the plow layer, which typically extends to a depth of 7 in; a pale brown eluviated horizon from a depth of 7 to 16 in; and a red-brown argillic horizon below that. The eluviated horizon was not continuous across the field. For reps 1 and 2, the pan was an eluviated horizon grading into an argillic horizon; for reps 3 and 4 the pan was essentially an eluviated horizon.

The draft and horsepower requirements of the slit-tillage tool was 75% of that for the subsoiler (Table 1) because of the shallower depth of the subsoiler in the slit tillage treatment. The shank of the slit tillage tool rode on the top of the pan while the blade below the shank did the actual penetration of the pan. The subsoiler had its shank lowered to the bottom of the pan disrupting a larger cross sectional area of the profile.

Sorghum yield was greater for slit tillage than the no-tillage treatment for 1986 through 1988 (Figure 1). Yield for the subsoiled treatment was significantly greater than the no-tillage treatment for 1986. The slit tillage treatment was significantly greater than the subsoiled treatment in 1987 and greater but not significantly in 1988. We speculated that the accumulation of slits from year to year caused the increase in sorghum yield of the slit tilled treatment over the subsoiled treatment.

After 1990, after tillage ceased, corn yield was greater for the subsoiled treatment than for the slit tillage treatment (Figure 2). Corn yield for the subsoiled treatments was highest in 1991, 1992 and 1993, though it was only significantly greater than for no-tillage in 1991. Corn yield was essentially the same for slit tilled and no-tillage treatment for all three years because the

Table 1. Draft and horsepower of slit and subsoil implements.

	Slit	Subsoil
Draft (lbs)	3930	5215
Power (hp/shank)	20.1	26.7

Figure 3 Ranks of Soil Strengths for 1990

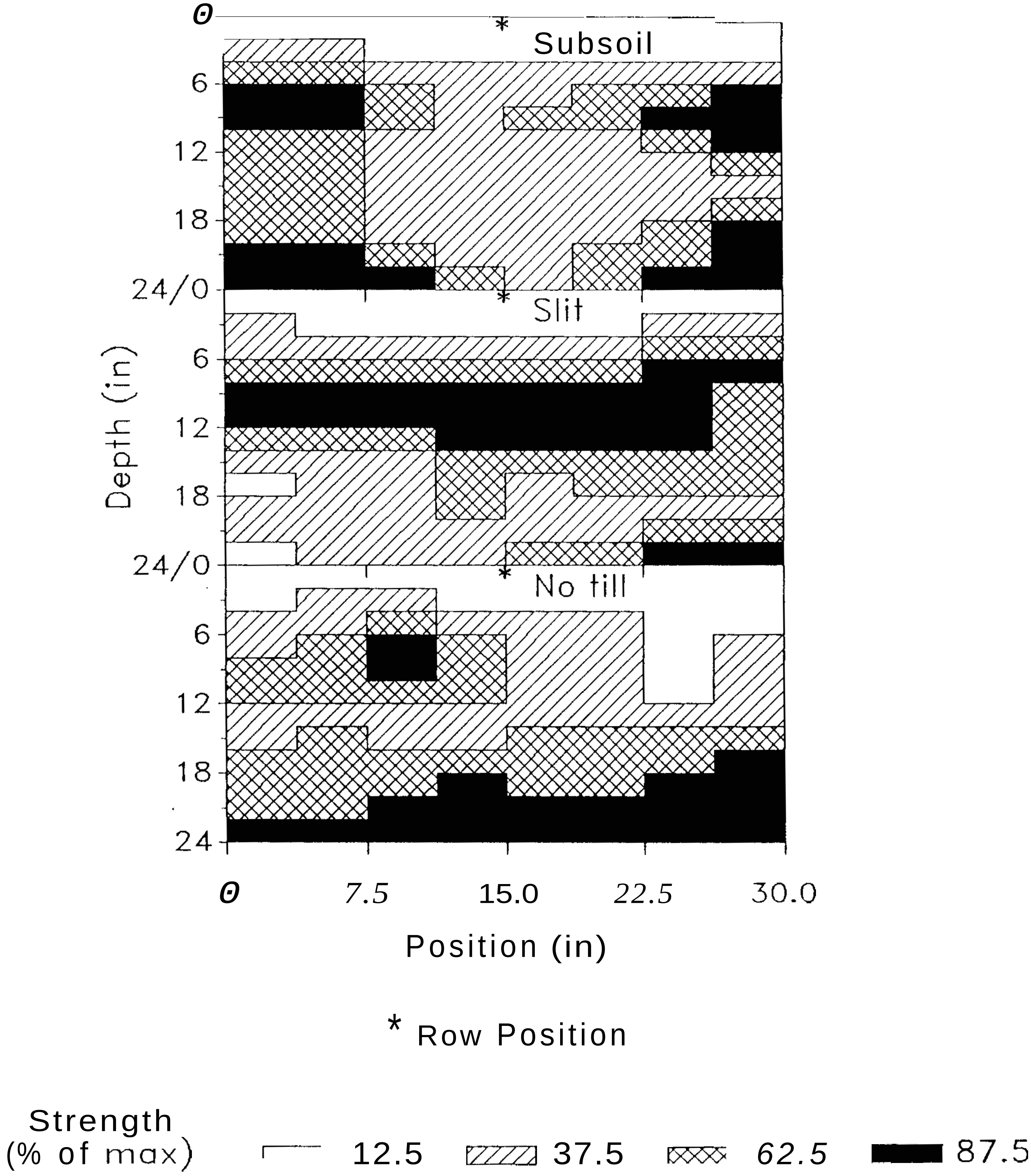
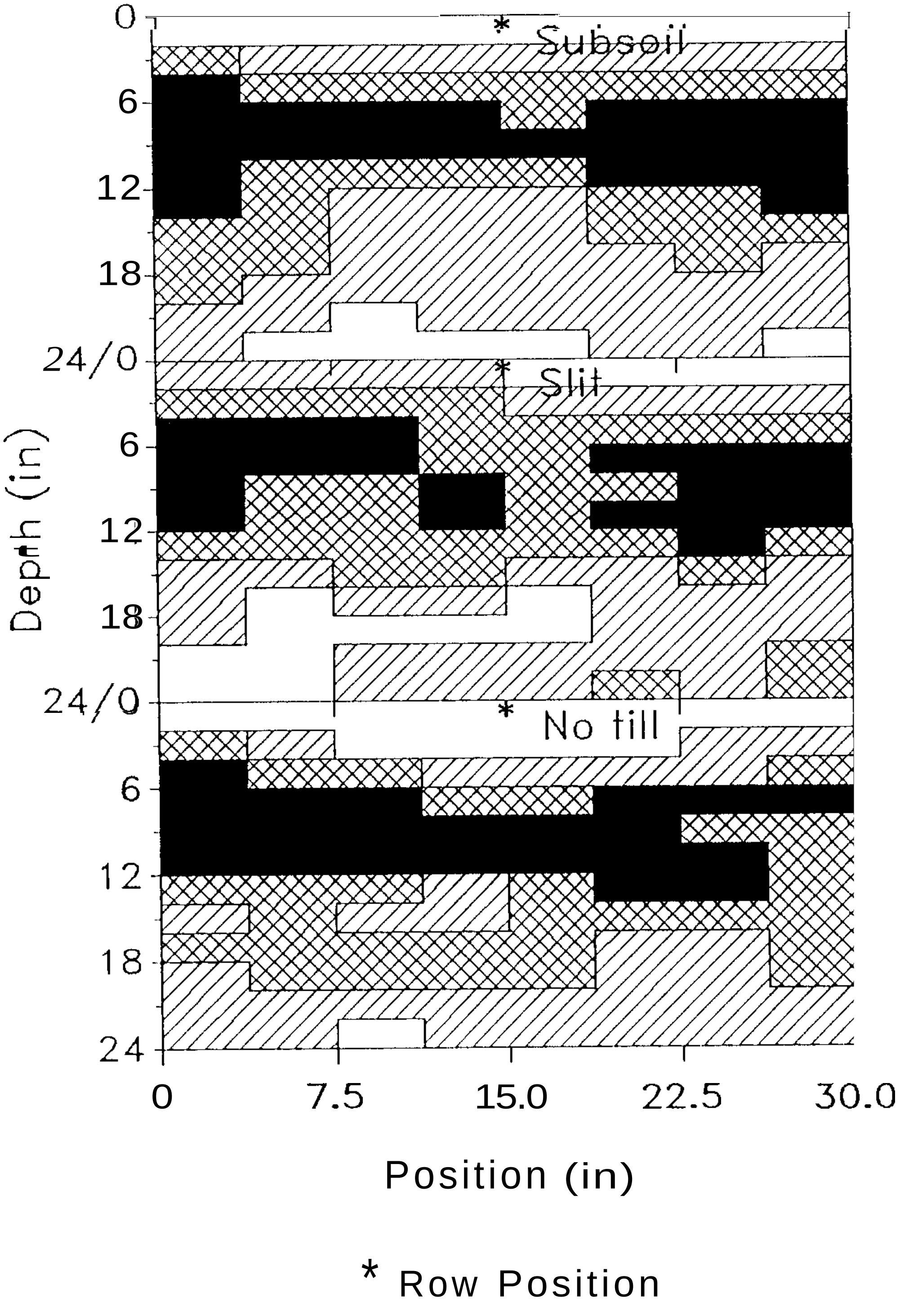


Figure 4. Ranks of Soil Strengths for 1992



* Row Position

Strength (% of max) ☐ 12.5 ▨ 37.5 ▩ 62.5 ■ 87.5

slits did not persist in this soil. Observations in the pits that were dug each year showed that most of the slits disappeared after about three years. Despite the lack of tillage and closure of the slits, a few roots were found at a depth of at least 3 ft in each treatment in each of the last three years of the study.

Soil strengths were ranked from highest to lowest and converted to a percent of the maximum. They were illustrated in Figures 3 and 4. Field plots were last tilled in 1989. Figure 3 shows the distribution of the strengths for September 1990, about a year and a half after the most recent tillage. The plot that had been subsoiled still showed the lower strengths below the row and the higher strengths under the mid rows. The slit tillage treatment which was not subsoiled as deeply had a more uniform strength across the profile. By August of 1992, three and a half years after tillage, all of the plots had uniform strengths across the plots and higher strengths within the subsoil pans (6 in to 12 in) than above and below them. From this we speculated that the greater yield of the subsoiled treatment was a result of the larger area of disruption of the subsoil shank when compared to the slit tillage treatment.

Because of the size of the cone (one half inch) used to measure the soil strength, slits (one-eighth-inch wide) could not be measured or seen in the strength diagrams (Figures 3 and 4). Therefore, slits were observed in the faces of the pit walls. Slits did not persist in this southeastern Coastal Plain soil. They disappeared after about three years. However, the lower energy requirement for slit tillage shows that it does have promise as an annual treatment. Its use as a tillage tool for these soils warrants further investigation.

Acknowledgements and Disclaimer

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