

**MINIMUM SUBSOILING FREQUENCY FOR CONSERVATION  
SYSTEMS IN THE TENNESSEE VALLEY**

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**Abstract**

For those soils that require deep tillage to alleviate soil compaction, subsoiling can be an expensive and time-consuming tillage event. Alternative tillage methods are needed which conserve natural resources without sacrificing cotton yields. An experiment was conducted in the Tennessee Valley Region of North Alabama to determine how frequently deep tillage is needed to alleviate soil compaction problems in these soils. Results over a two-year period that consisted of cotton (*Gossypium hirsutum* L.) yields resulting from tillage three-years previous, two years previous, and one year previous found no differences in crop yield. No differences between four tillage implements were also found with all tillage treatments resulting in similar yields.

**Introduction**

Some soils in the Southeastern United States are severely degraded from excessive erosion and require intensive management including practices to alleviate soil compaction. Soils in the Tennessee Valley region of North Alabama have been found to respond positively to management practices that include a cover crop. Improved crop yields, improved soil tilth, reduced soil compaction, and reduced risk have been associated with experiments that have proven the benefits of cover crops (Raper *et al.*, 2000a; Raper *et al.*, 2000b; Schwab *et al.*, 2002). These same experiments have also shown benefits of conservation tillage practices that include either in-row subsoiling or bent-leg subsoiling. However, this tillage practice is expensive and time-consuming. Many producers would be interested in using this practice to alleviate their soil compaction problems if it was not required to annually subsoil. Therefore, an experiment was conducted to determine the long-term benefits associated with reducing soil compaction by using several methods of subsoiling.

**Methods and Materials**

The experiment was begun in 1999 with fall tillage being applied at the Alabama Agricultural Experiment Station's Tennessee Valley Substation in Belle Mina, AL. The soil type is a Dewey silt loam (clayey, kaolinitic, thermic Typic Paleudult). Prior to this tillage, the field had been conventionally tilled for cotton production for many years.

This study was designed to compare the long-term benefits of four different conservation tillage systems including a Kelley Manufacturing Company's (Tifton, GA) Rip/Strip in-row subsoiler, a Bigham Brothers' (Lubbock, TX) Paratill® bentleg subsoiler, a Bigham Brothers' Teratill® bentleg subsoiler, and a no-till treatment. Two of the implements were selected (Rip/Strip in-row subsoiler and the Paratill®) because they were commonly being used by producers in this region. The Teratill® was selected because it was being marketed as an alternative to the Paratill® with a smaller draft requirement and reduced soil disruption.

The experimental design was a randomized complete block with a 3x3 factorial arrangement of treatments augmented with an additional control treatment of no-tillage with a cover crop. The two factors were: 1) tillage implement (in-row subsoiler, Paratill, and Terratill), and 2) tillage application (annual, biennial, and triennial). Each treatment was replicated four times. The experiment was set up in a staggered form with the first set of tillage treatments conducted in the fall of 1999. Annual tillage treatments were conducted with each implement as well as other tillage treatments that would allow complete results to be obtained for annual tillage, biennial tillage, and triennial tillage in years 2002 and 2003. These two years of complete yield data should allow reasonable comparisons to be made for all tillage treatments and to determine if reconsolidation occurs for these soils once they are disturbed and managed by conservation tillage systems. All treatments included the use of a rye (*Secale cereale* L.) cover crop because previous experiments had found benefits associated with its use (Raper *et al.*, 2000a; Raper *et al.*, 2000b; Schwab *et al.*, 2002).

The plots were four 40-inch rows wide by 175 ft. long. The substantial length of these plots was selected to attempt to consider the natural variability in soil strength that may occur over a farm. The center two rows were harvested and weighed to obtain cotton yield.

To determine the depth of tillage, multiple cone-index profiles were obtained in plots that had been used to grow conventionally tilled cotton. These measurements showed that the depth of the compacted soil layer began at approximately 12 inches. Therefore, the depth of tillage was set to be at 13 inches.

The factorial arrangement of 10 treatments within the randomized complete block was analyzed with an appropriate ANOVA model using SAS. The augmented control treatments effects were also separated using single degree of freedom contrasts. A predetermined significance level of  $P \leq 0.10$  was chosen to separate treatment effects.

### **Results and Discussion**

During all years of the experiment, few differences in cotton lint yield were found as a result of the various tillage implements or the time since their use. In 2002, cotton lint yield showed no overall treatment effect ( $P \leq 0.23$ ; Figure 1). However, using single degree of freedom contrasts averaged across years, the Terratill® was found to improve cotton lint yield (2052 lb/ac) compared to the in-row subsoiler (1829 lb/ac;  $P \leq 0.01$ ) or the Paratill® (1917 lb/ac;  $P \leq 0.08$ ).

In 2003, similar results for cotton lint yield were found with no overall treatment effect ( $P \leq 0.16$ ; Figure 2). However, when averaged across tillage implements and separated using single degree of freedom contrasts, annual tillage was found to result in higher yields (3113 lb/ac) compared to tillage every three years (2959 lb/ac;  $P \leq 0.10$ ).

Averaged across both years, no significant treatment effect was found ( $P \leq 0.38$ ; Figure 3). A slight trend was found using single degree of freedom contrasts to examine differences between annual tillage (2493 lb/ac) and tillage every 3 years (2432 lb/ac;  $P \leq 0.12$ ). However, one should especially take note that no differences were found in any year or in the averaged year data with respect to differences between the no-till treatment and any other tillage treatment including the various implements or the time since their use.

### **Conclusions**

1. Cotton lint yield was found to be statistically similar between no-tillage and all tillage treatments.
2. Cotton lint yield was found to be statistically similar between all three tested tillage implements.
3. Cotton lint yield was found to be statistically similar between annual, biennial, and triennial tillage.
4. A slight trend did exist that indicated annual tillage increased cotton lint yield over tillage conducted three years previous.

### **Disclaimer**

The use of trade names or company names does not imply endorsement by USDA-ARS or the Alabama Agricultural Experiment Station.

### **References**

- Raper, R.L., D.W. Reeves, C.H. Burmester, and E.B. Schwab. 2000a. Tillage depth, tillage timing, and cover crop effects on cotton yield, soil strength, and tillage energy requirements. *Applied Eng. Agric.* 16(4):379-385.
- Raper, R.L., D.W. Reeves, E.B. Schwab, and C.H. Burmester. 2000b. Reducing soil compaction of Tennessee Valley soils in conservation tillage systems. *J. Cotton Sci.* 4(2):84-90.
- 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. *J. Soil Sci.* 66:569-577.

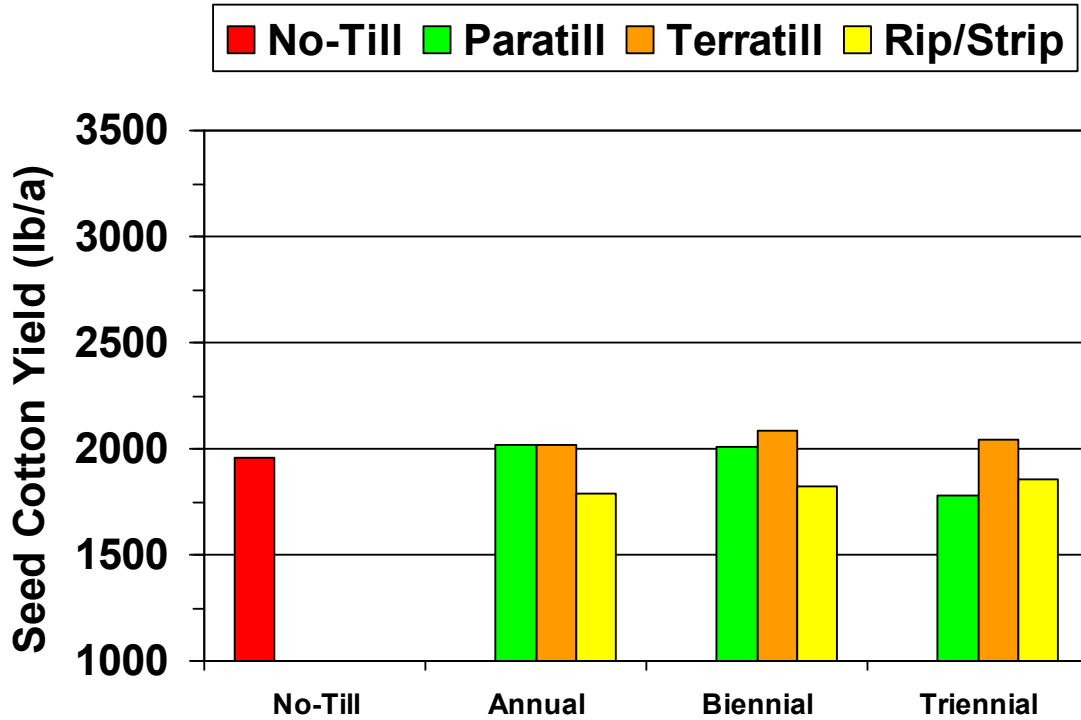


Figure 1. Cotton lint yield averaged over all replications for 2002.

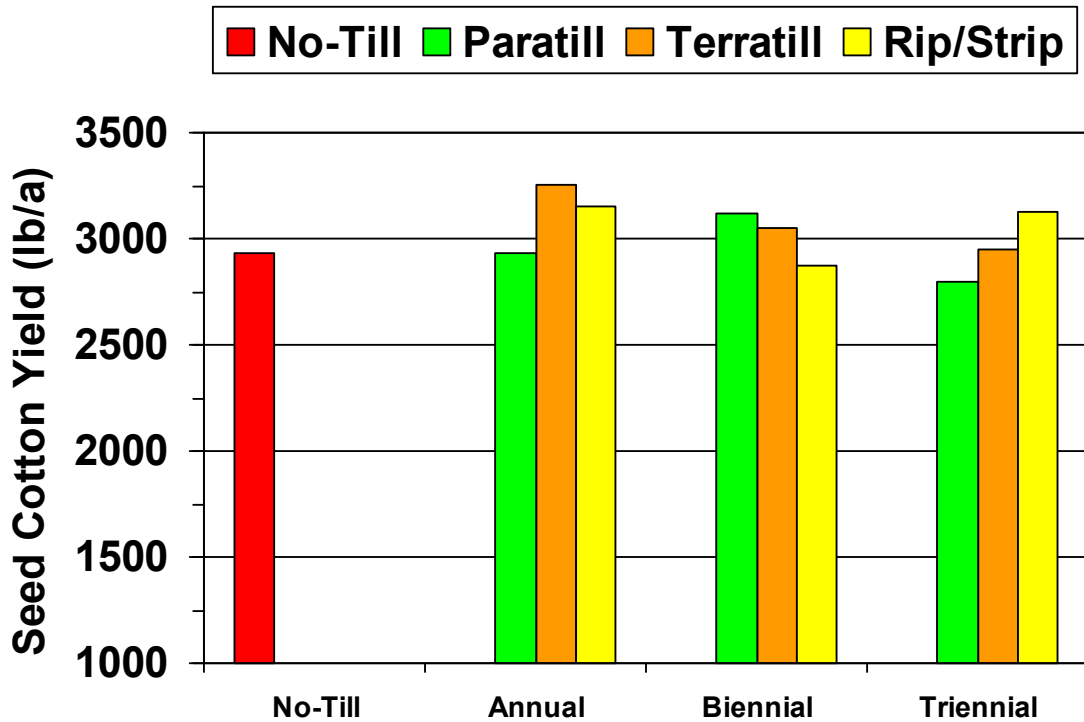


Figure 2. Cotton lint yield averaged over all replications for 2003.

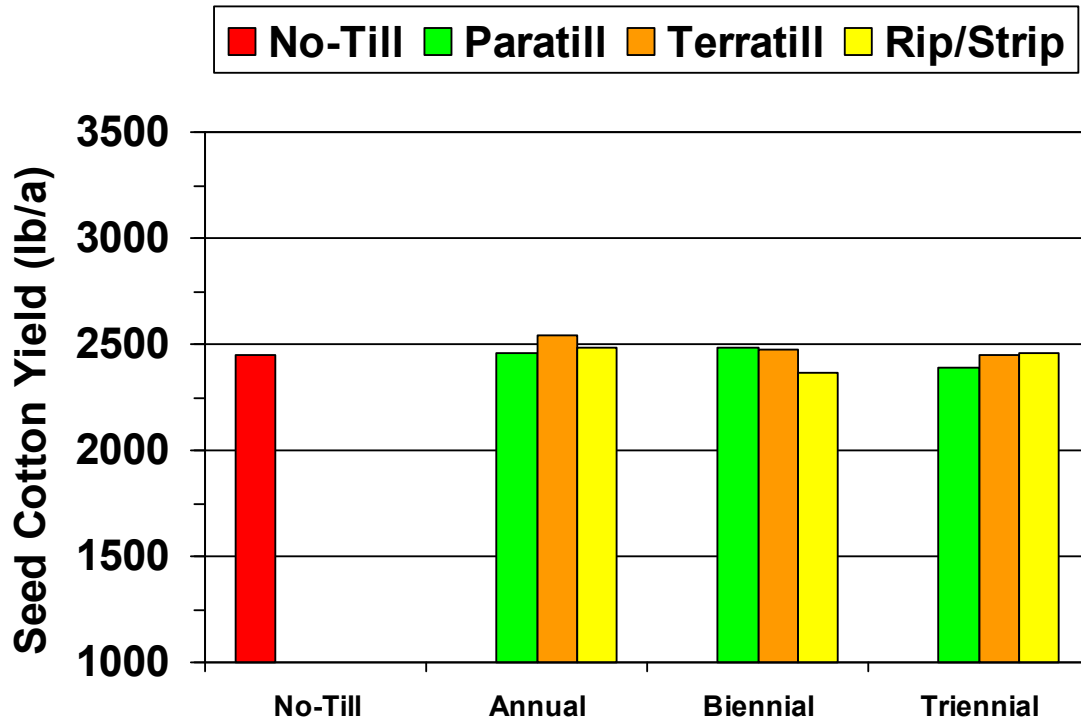


Figure 3. Cotton lint yield averaged over all replications and years.