Interseeding Conservation System: Compaction and Plant Response

A. Khalilian, C. E. Hood, J. H. Palmer and F. Holbrook[1]

Introduction

Doublecropping with intensive management practices is a viable economic alternative for obtaining greater net returns per acre. Major problems with current doublecropping systems include inadequate moisture for germinating the row crop following grain harvest, excessive crop residue, and reduced yield of the soybeans due to delayed planting. In addition, current methods induce excessive soil compaction resulting in hardpans that require energy-intensivedeep tillage under less than optimum moisture conditions in early June.

A new interseeding system developed at Clemson University allows planting of soybeans into standing small grain with a controlled-traffic scheme. This improves moisture availability for seed germination and increased soybean yields, allows better management of crop residues, and has the potential to reduce energy for deep tillage. This low-power system operates at 4 to 6 mph and utilizes danish tines as seedbed preparation devices. Small spring-mounted fingers mounted behind the seed-drop tubes help with soil coverage of the seed (Figure 1). The idea is to plant wheat in the fall in 13-inch rows (with a 24-inch spacing between third and fourth rows and eighth and ninth rows to allow passage of tractor and combine tire between rows). Soybeans are then interseeded between rows of standing wheat in late April or early May when conditions are usually more desirable for optimum stands and early crop growth.

[1]Associate Professor and Professor, Agricultural Engineering Department, Clemson University; Professor, Agronomy and Soil Department, Clemson University; and Agricultural Engineer, South Carolina Land Resources Commission.

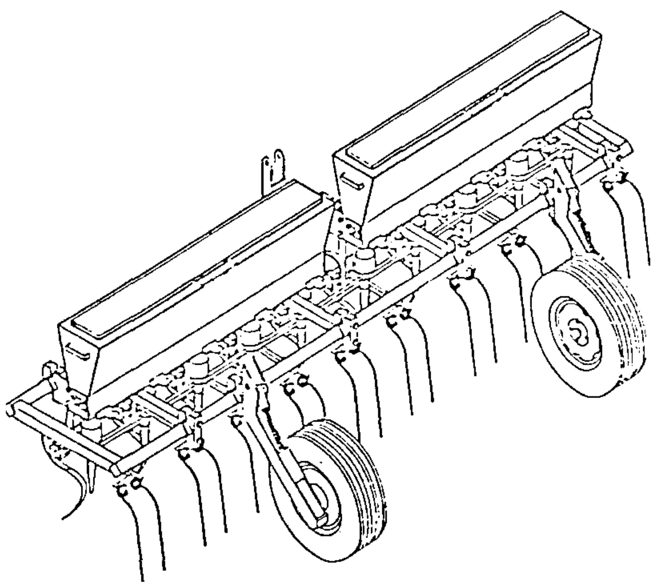

Figure 1. The Clemson Interseeder.

Intercropping of soybeans into wheat has been successful in the Midwest. Chan et al. (1980) reported that interseeding soybeans into small grain did not affect small grain yields. In a 3-year study, Reinbott et al. (1987) indicated that intercropped soybeans yielded 28 percent more than conventional doublecropped soybeans.

Research is needed to determine the feasibility of intercropping soybeans into standing wheat for Coastal Plain soils. In addition, studies are needed to optimize intercropping tillage practices using controlled-traffic production methods. This study focused on performing primary tillage in the fall prior to wheat planting.

Objectives

The objectives of this study were:

(1) To determine proper tillage system for interseeding soybeans into standing wheat;

(2) To compare yields of wheat and soybeans planted in 13-inch rows with conventional double-cropping methods; and

(3) To determine the effects of the new tillage/planting system on wheat root and shoot growth and soil hardpan formation.

Methods and Materials

The test was conducted on Dothan sandy loam at the Edisto Research and Education Center, Blackville, South Carolina. Tillage tools included a four-shank paraplow with a 20-inch horizontal spacing of the legs, operating 12-13 inches deep; an 11-foot wide chisel plow with the chisel shanks spaced on 12-inch centers, operating 11 inches deep; a four-row KMC subsoiler-planter with 38-inch subsoiler shank spacing, operating 12-13 inches deep; and a 15-foot wide tandem disk.

A randomized complete block design with six replications was the statistical model selected for evaluating the tillage/planter treatments. The six treatments are outlined in Table 1.

Wheat was planted November 25, 1986 immediately after tillage. Seeding rate was 90 Ib/acre. Shoot growth was measured by clipping the wheat plant 2 months after planting.

Table 1. Tillage/plantinp: treatment combinations.

Treat. no.	Tillage before wheat			Wheat planting method		Tillage before soybeans	Soybean planting method	
	Disk	Chisel	Para	Clem	Drill	Paraplow	Clem	KMC/Sub
1.	x			x			1*	
2.	x			x			2**	
3.	x	x		x			1	
4.	x		x	x			1	
5.	x		x	x		x	2	
6.	x	x			x			2

*1 - Soybeans interseeded on May 20 and replanted on June 18
**2 - Soybeans planted on June 9 after wheat harvest.

Clem = Clemson interseeder; Drill = conventional grain drill with 7-inch rows; KMC/sub = subsoiler-planter with 38-inch rows; para = paraplow.

Root growth was measured by taking core samples at depths of 0 to 6, 6 to 12, and 12 to 18 inches. A total of 54 cores were taken per treatment. The roots were washed from the soil samples and oven dried for root dry weight determination.

A tractor-mounted, recording soil penetrometer was used to quantify soil resistance to penetration. Cone index values were calculated from the measured force required to push a 0.5-inch-square base area, 30-degree cone into the soil. Penetrometer data were taken prior to tillage and 2 months after planting.

The soybean variety Gordon was interseeded at a rate of 40 Ib/acre between rows of standing wheat on May 20, 1987. Only the plots in treatments one, three, and four were interseeded with soybeans (Table 1). An excellent stand of interseeded soybeans was obtained. Wheat from all plots was harvested on June 4, and soybeans were planted on June 9, in plots of treatment five (tilled with the paraplow 12-13 inches deep before planting), treatment two with the Clemson interseeder, and treatment six with the KMC subsoiler-planter. Because of damage to soybean plants caused by misapplication of an herbicide, it was decided to replant the interseeded plots (originally planted on May 20) on June 20, 1987. Penetrometer readings were taken from soybeans plots on July 10. Soybeans were harvested on November 4, 1987.

Table 2. Shoot weight, nitrogen uptake and average cone index 2 months after planting and wheat yield.

Tillage	Planter	Shoot weight (lb/a)	N uptake (% DM)	Av cone index* (psi)	Wheat yield (Bu/a)
Paraplow	Clem.	515 a	3.83 a	96 a	50.0 a
Chisel	Clem.	388 b	3.55 a	129 a	47.4 a
Chisel	Drill	306 c	3.66 a	178 b	47.3 a
Disk	Clem.	231 c	2.93 b	200 b	30.0 b

* Cone index values are averaged over the E horizon (hardpan area), depth = 8 to 11 inches.

Results and Discussion

Two months after planting, a big difference in growth rate of wheat was observed in different tillage plots. Paraplow plots had the highest shoot growth (515 lb/acre drymatter) followed by chisel plow (388 Ib/acre) and disk (231 Ib/acre). Also, there was a significant difference between chisel plots planted with the Clemson interseeder and chisel plots planted with a conventional grain drill (Table 2).

Figure 2 shows root distribution at different depths for tillage and planter combinations 2 months after wheat planting. The 12 to 18-inch (clay) zone contained about 15 percent of total roots in paraplow plots followed by chisel plow plots planted with Clemson interseeder (12percent), chisel with grain drill (9 percent), and disk plots planted with the Clemson interseeder (5 percent). There was a good relationship between root weight at this depth and shoot weight. The correlation coefficient was 0.96 (significant above 95 percent level). Shoot weight increased as root penetration of the clay layer increased. Cone index values at different penetrometer depths before tillage indicated that the test field had a hardpan about 8 to 11 inches deep. The data showed that initial soil conditions were similar for all treatments.

Figure 3 shows the effects of tillage/planting systems on the soil cone index 2 months after planting wheat. The paraplow greatly reduced soil compaction, especially in the E horizon or hardpan area. Results of the analysis of variance on cone index values averaged over depths of 8 to 11inches showed a significant difference between paraplow and disk plots (Table 2). Also, there was a significant difference between chiseled plots planted with the Clemson interseeder and grain drill. This may have been due to press wheels and double disk openers on the grain drill that compacted the soil.

Using generally accepted criteria that cone index values above 290 psi stop root growth (Taylor and Gardner 1963, and Carter and Tevernetti 1968), it is evident that all tillage tools greatly reduced soil compaction. Cone index values in

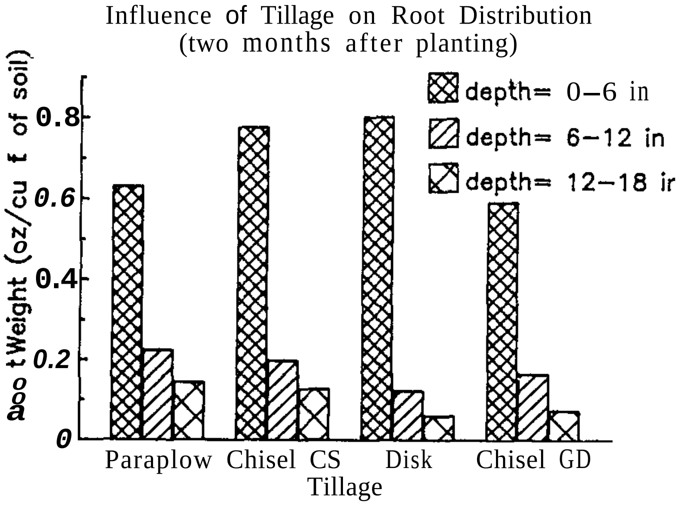

Figure 2. Root **distribution at different depths for tillage and planter combination 2 months after wheat planting.**

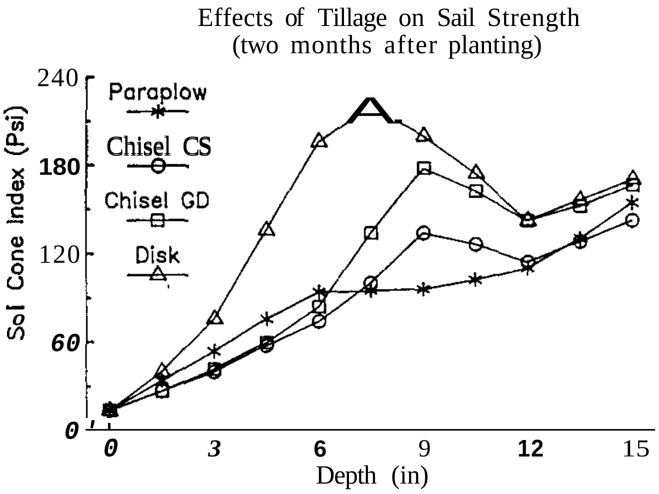

Figure **3**. Cone penetrometer profiles **2** months after tillage in the fall.

hardpan for disk plots were not high enough to completely eliminate root penetration into the clay layer.

A very good correlation between average soil cone index in the E horizon (hardpan) and root dry weight in clay was demonstrated. This indicates that hardpan in Coastal Plain soils acts like a root filter. The amount of roots in the B horizon depends on the hardness of this compacted layer.

Deep tillage increased nitrogen uptake by the wheat plant (Table 2). This resulted in a forage with higher protein content for winter grazing. The paraplow plots produced significantly higher wheat yields than any other tillage treatments. There was no significant difference in yield between chisel plots planted with the Clemson interseeder and those planted with a grain drill. Disk plots produced 27 percent less yield compared to paraplow. Interseeding soybeans into standing wheat 2 weeks before harvest did not reduce wheat yield.

Table *3* shows the soil cone index values averaged over the top 15 inches of soil depth for soybean plots one month after planting. Two sets of penetrometer readings were taken for each plot, one from the soybean rows and the other from the tractor tire tracks.

Results of the analysis of variance on cone index values averaged over the top 15 inches showed significant difference between disk plots and other tillage treatments. There was no significant difference between paraplow plots tilled in fall, with those of conventional doublecropping plots (chisel plow in fall followed by subsoiler prior to planting soybeans). Paraplowing after wheat harvest significantly reduced soil compaction compared to other tillage treatments. However, there was no statistically significant difference between plots paraplowed only once in fall of 1986 and those which had extra tillage operation with paraplow in June, 1987.

Traffic significantly increased soil compaction as shown by penetrometer measurements within the soybean rows (Table 3). Figure 4 shows profiles of cone index versus depth for paraplow plots about 8 months after tillage operations. The biggest difference in soil compaction was experienced in the hardpan area. Similar trends were also observed in other tillage plots. This indicates that one tillage operation in the fall, deep enough to remove root inhibiting hardpans, in conjunction with controlled traffic, could eliminate deep tillage of any kind for soybeans.

Paraplowing prior to planting soybeans significantly increased crop yield (Table 3). Statistically, there was no significant difference among chisel plow plots planted with the Clemson interseeder, chisel plots planted with the KMC subsoiler/planter (conventional doublecropping) and paraplow plots with no deep tillage prior to soybean planting. Disk plots produced significantly less soybeans per acre than any other tillage/planter combinations.

Table **3.** Cone index values and yield from soybean **plots.**

Tillage		Planter		Av cone index (psi)		Yield
Wheat	**Soybean**	**Wheat**	**Soybean**	**Row**	**Tire**	**(Bu/a)**
Disk	**None**	**Clem.**	**Clem.***	**140 a**	**156 a**	**18.7** *c*
Disk	**None**	**Clem.**	**Clem.****	**166 a**	**192 a**	**19.6 c**
Chisel		**Clem.**	**Clem.***	**114 h**	**138 a**	**21.5 h**
Chisel	**Subsoil**	**Drill**	**KMC****	**106 bc**	**146 a**	**25.9 ah**
Para.	**None**	**Clem.**	**Clem.***	**106 bc**	**128 a**	**23.5 ab**
Para.	**Para.**	**Clem.**	**Clem.****	**96 c**	**110 b**	**31.1 a**

*** Soybeans interseeded on May 20 and replanted on June 18.**
****Soybeans planted on June 9 after wheat harvest. Cone index values are averaged over the top 15 inches.**

Summary of Results

(1) Paraplow plots produced higher dry matter per acre than any other tillage tools. There were significant differences be-

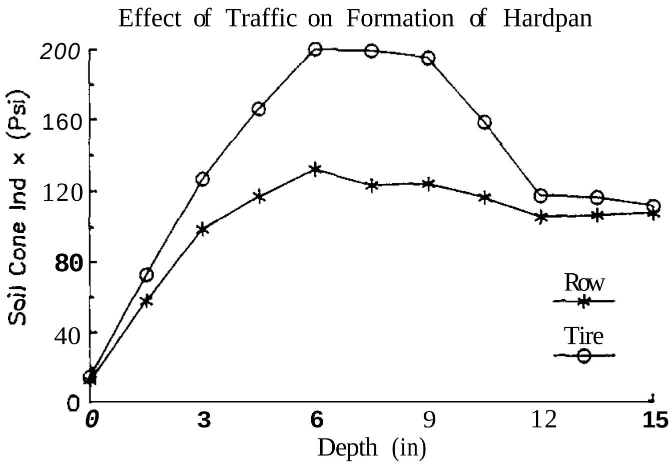

Figure **4. Effects** of traffic **on** formation **of** hardpan **8** months after tillage with paraplow.

tween chisel plots planted with the Clemson interseeder and chisel plots planted with a conventional grain drill

(2) Fifteen percent of the total roots in paraplow plots were at depths between 12to 18inches in clay, followed by 12 percent in chisel plots planted with the Clemson interseeder, 9 percent in chisel plots planted with a grain drill, and only 5 percent in disk plots.

(3) Shoot weight increased as root penetration of the clay layer increased. Also very good correlation existed between root dry weight and root length.

(4) The paraplow greatly reduced soil compaction, especially in the E horizon. Also, there were significant differences between chisel plots planted with the Clemson interseeder and those planted with a grain drill. A very good correlation between average soil cone index in the E horizon and root dry weight in the B horizon was demonstrated.

(5) Paraplow plots produced wheat with the highest levels of nitrogen uptake. Also, the paraplow plots produced higher wheat yields than any other tillage treatments. There was no significant difference in yield between plots planted with the Clemson interseeder and those planted with a grain drill. Interseeding soybeans in between rows of standing wheat did not affect wheat yield.

(6) Traftic significantly increased soil compaction as shown by comparing penetrometer readings within the soybean rows and between rows.

(7) Using controlled traffic, one deep tillage operation in the fall appeared adequate for doublecropping.

(8) There was no significant difference in the soybean yields between the plots subsoiled after wheat harvest and the paraplow plots planted with the Clemson interseeder. Disk plots produced significantly less soybeans than all other treatments.

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