SOIL PROFILE MODIFICATION COMPARED TO TRADITIONAL TILLAGE - 1994
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Abstract

The response of cotton to soil profile modification was compared to the response to traditional tillage practices during the 1994 crop season. A wide-bed controlled-traffic production system was used on Tunica clay soil. Traditional tillage treatments included 1) bed only, 2) disk and bed, 3) chisel and bed, and 4) subsoil and bed. Profile modification depths ranged from 0 to 30". Data collected during the study included plant population, plant height, Nodes Above White Flower (NAWF), vegetative biomass, boll biomass, yield, and lint quality. Results showed that plant height, plant mass, and seed cotton yield were significantly improved by profile modification.

Introduction

Clay soils make up about 50% of the soil in the Lower Mississippi Delta. These soils are very fertile but crops grown on them quickly experience water-deficit stress during dry periods of the growing season. This condition can be alleviated by irrigation, but this is a costly practice which most farmers do not use. Prior work (Smith, 1995; Wesley and Smith, 1991) has shown that deep tillage in the fall, in relatively dry clay, provides an alternate solution to the water-deficit stress problem. This solution is thought to be the result of rearranging the structural soil units (blocks) so that the volume of macropore space between them is increased; therefore, water infiltrates into the soil at a faster rate and surface runoff is reduced. This investigation extends the concept of increasing macropore space volume from rearranging soil structural blocks to breaking up the structural blocks by the process of profile modification.

Modification of the soil profile has been used to promote better soil water relations and alleviate mechanical and chemical restrictions to root growth. Mech et al. (1967) used a backhoe to modify the profile of a silt loam soil with a clay subsoil. By mixing the A and B soil horizons, they decreased soil bulk density, increased root proliferation in the B horizon and generally increased crop yields. Eck and Taylor (1969), used a trenching machine to modify the profile of a Pullman silty clay loam. Profile modification to depths of 3' and 5' improved grain sorghum yields by 66 and 80 percent, respectively, compared to non-modified plots. Heilman and Gonzalez (1973) modified a Harlingen clay soil with a trenching machine by using 5" trenches spaced 40" apart. This treatment, installed to a 24" depth, improved cotton yields by 22% with soil backfill and 43% with soil-vermiculite backfill. Cotton yield improvement with soil backfill for a 40" modification depth was 25% compared to non-modified treatments.

Materials and Methods

A field experiment was established during the fall of 1993 on Tunica clay (clayey over loamy, montmorillonitic, non-acid, thermic Vertic Haplaquept). Ten treatments, replicated 4 times, were installed in plots 49.2' wide x 100' long (6 wide-beds x 100') using a wide-bed controlled-traffic production system (Table 1). Two rows of cotton with a 40" spacing were planted on each wide-bed (Fig. 1).

Profile modification treatments (T5 through T10) were installed with an experimental implement designed to perform the equivalent of a trench-backfill operation in a single pass. It was operated from the tractor PTO and used a creeping drive mechanism to control forward travel speed of the machine. While digging, the implement pushed the tractor (tractor transmission in neutral), but while transporting or turning, the drive mechanism of the implement was disabled with tractor hydraulics to allow it to operate as a trailed implement. This implement modified a strip 56" wide to a maximum depth of 30". The depth could be set to any desired value between 0 and 30" by using auxiliary tractor hydraulics. Power requirements were less than 60 hp due to the slow rate of forward travel which ranged from 31 to 46 in/min.

Cotton variety Stoneville 453 was planted on 4/26/94 and seed furrow treatments of Ridomil PC-11G and Temik 15G were applied. Preplant nitrogen (93 lbN/a) was applied on 4/25 and an additional sidedress application of 20 lbN/a was applied on 6/14. Insect pest populations were controlled through recommendations from a professional scout. The season was unusual in that rainfall during July (8.4") prevented water-deficit stress during the primary fruiting period.

Data collected during the growing season included plant population, plant height, NAWF, # bolls, vegetative biomass, boll biomass, yield and lint quality. Population means were computed from counts of all plants in a 10' length of row at three random locations within each plot. Height was measured on 7/7 and 8/2. The July measurements consisted of height measurements of 10 plants from each plot. The August measurements were made from plant samples consisting of all plants from 39" of row. After measuring the height and 'nodes above white flower' (NAWF), the green bolls were removed from the plants and then each component (vegetative parts and bolls) was separately cut into small pieces in preparation for drying. This material was then placed in paper bags and

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dried in a forced draft oven at 70°C until mass change over a 24 hour period had stabilized. Seed cotton yield was computed as the average of 32 samples composed of 8 samples (100' x 3.33') from each of 4 replications. Non-modified treatments were harvested on 9/28 and 10/04 and modified treatments were harvested on 10/04 and 11/02. Approximately 35 lb of seed cotton was bagged from each plot during the first pick harvest for fiber quality evaluation. After ginning each sample on the USDA Microgin, 3 sub-samples of lint were collected for classing at the USDA classing office in Dumas, Arkansas. Each value of fiber quality data presented is the average of 12 measurements composed of 3 sub-samples from each of 4 replications.

Treatments with profile modification matured about 1 week later than non-modified treatments. Harvest was performed as a twice over harvest and samples were ginned for lint quality evaluation.

Results and Discussion

Plant population, height, mass, and NAWF data are summarized in table 2. Populations varied from 25,700 to 31,690 plants/acre (Fig. 2). Treatments 2 through 10 were statistically similar in population, and T1 was significantly lower in population than all other treatments except T9 and T10.

Plant height was influenced by tillage (Fig. 3). The non-modified treatments were shorter than any modified treatment on both dates, T1 was the shortest treatment on both dates, and the tallest plants occurred on the 30" modification depths (T5 and T8). During the period 7/7 - 8/2, height increased in the non-modified treatments by an average of 7.9 ", but the modified treatment heights increased by an average of 9.4". This growth period was very wet and the plants did not experience water-deficit stress; therefore, improved growth must be due to better drainage or improved root proliferation throughout the root zone.

Aboveground plant biomass was also evaluated from the samples collected on 8/2 from 39" of row in each plot of reps 1 and 2. Results showed that T1 produced the smallest amount of vegetative and boll biomass (Fig. 4). Non-modified treatments (T1,T2,T3,T4) produced less vegetative biomass than modified treatments. Within the modified treatments (T5,T6,T7,T8,T9,T10), increased modification depth tended to increase vegetative biomass. Boll biomass on 8/2 did not appear to be significantly influenced by tillage treatments.

NAWF measurements on 8/2 showed that all treatments were statistically similar, but treatment 1 was the least numerically at 3.9 and treatment 10 was the greatest at 5.1. The NAWF values were not correlated with height or aboveground biomass.

Treatment yield and lint quality data are presented in table 3. Yields for all modified profile treatments (except T10) were significantly greater than yields from non-modified treatments (Fig. 5). Within the modified profile treatments, yield from the 30" depth treatments were significantly better than most 10 and 20" treatments, and yields from 10" and 20" depths were similar to each other. All non-modified treatments were similar in yield except T1 which was significantly less than the rest.

Fiber quality data from table 3 shows that grade index was influenced by tillage but that staple length, micronaire, fiber strength and length uniformity were not. Treatments 5 and 8 (30" depth) had the best average grade index of 98.5 and 99, respectively. All modified profile treatments had better grade index values than non-modified profile treatments (Fig. 6). This result is economically significant because the tillage treatments which produced the highest yield also had the highest grade.

The remaining fiber quality measurements were in the normal range except for some micronaire values. Staple length ranged from 34.3 to 34.6 32nds (1.07 to 1.08"). Micronaire was within the base range except for T1 and T2 which fell in the discount range with values of 5.0 and 5.1. Fiber strength values ranged from 25.7 to 26.5 gms/tex which is considered to be in the intermediate range for fiber strength. Degree of uniformity was also intermediate with values ranging 81.9 to 82.7.

Acknowledgements

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Table 1. Tillage treatments and implements used to install them.

Trt	Description	Implement
1.	Bed-Only	6-row hipper
2.	Disk Harrow and Bed	Disk harrow (twice) plus 6-row hipper
3.	Chisel (8 - 10") deep and Bed	80" wide chisel plow plus 6-row hipper
4.	Subsoil (16 - 18") deep and Bed	Parabolic subsoiler (2 shank @ 40" spacing) 6-row hipper
5.	Profile Modification (30" deep, annually)	Experimental modification implement (56" wide x 30" deep) plus rice levy plow to shape
6.	Profile Modification (20" deep, annually)	Same as 5 but (56" wide x 20" deep)
7.	Profile Modification (10" deep, annually)	Same as 5 but (56" wide x 10" deep)
8.	Profile Modification (30" deep, residual)	Same as 5 first year, but disk and hip thereafter
9.	Profile Modification (20" deep, residual)	Same as 6 first year, but disk and hip thereafter
10.	Profile Modification (10" deep, residual)	Same as 7 first year, but disk and hip thereafter

Table 2. Plant measurements collected during the 1994 growing season.

			Plant Measurements made on 8/2/94			
Trt	Plant Pop. (#/a) x 10^{-3}	Height (7/7/94) (in)	Height (in)	Veg. Biomass (oz/ft^2)	Boll Biomass (oz/ft^2)	NAWF
1.	25.7	22.4	30.4	1.20	0.31	3.9
2.	30.9	24.6	32.4	1.62	0.41	4.6
3.	30.4	23.3	30.9	1.74	0.44	4.2
4.	30.3	25.7	33.6	1.73	0.56	4.5
5.	31.0	30.1	37.4	1.81	0.37	4.2
6.	31.7	26.7	36.9	1.84	0.38	4.4
7.	30.5	26.4	36.7	1.82	0.43	4.9
8.	31.3	28.7	38.3	2.04	0.43	4.3
9.	30.1	27.6	36.7	1.86	0.33	4.4
10.	29.1	26.7	36.3	1.79	0.47	5.1
$LSD_{.05}$	4.4	3.1	7.1	0.67	0.17	1.87

Table 3. Treatment yield and lint quality from field 5, Frankel Farm, 1994.

Trt.	Yield (lb seed cot /a)	Grade Index	Staple Length (32^{nds})	Micro-naire	Fiber Strength (gm/tex)	Length Unifor-mity (%)
1	2380	95.5	34.3	5.1	26.4	82.0
2	2850	95.7	34.5	5.0	26.3	82.4
3	2810	94.5	34.3	4.9	26.4	82.3
4	2700	94.0	34.3	4.8	26.5	82.3
5	3370	98.5	34.4	4.8	25.8	82.6
6	3110	98.0	34.6	4.9	25.7	82.5
7	3110	98.5	34.4	5.0	26.0	82.1
8	3300	99.0	34.4	4.9	25.7	82.2
9	3160	98.0	34.5	4.9	26.0	82.7
10	2850	96.3	34.3	4.8	26.1	81.9
$LSD_{.05}$	176	2.8	0.6	0.2	0.5	0.5

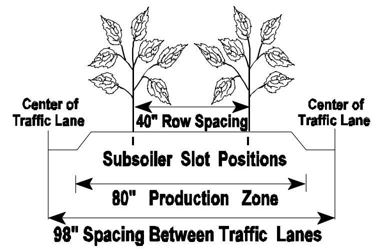

Figure 1. Wide-bed controlled-traffic production system for cotton production. All machinery traffic is restricted to the 18" traffic lanes.

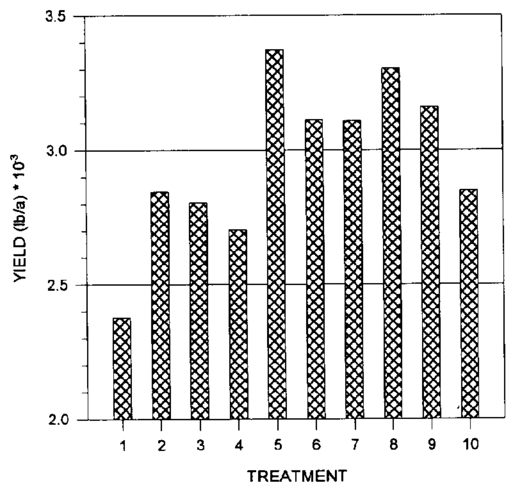

Figure 2. Seed cotton yield from twice over harvest. Each value is the average of 8 samples from each of 4 replications.

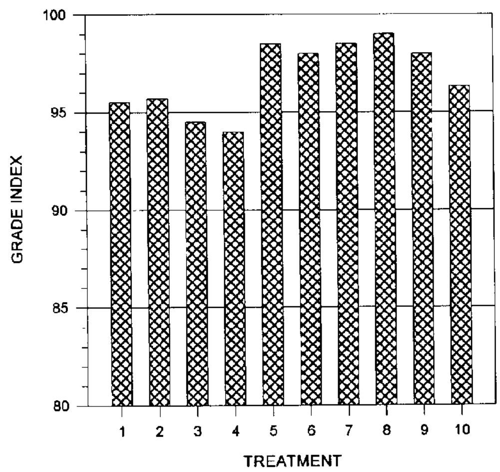

Figure 3. Average classer's grade-index computed from 3 samples from each of 4 reps.