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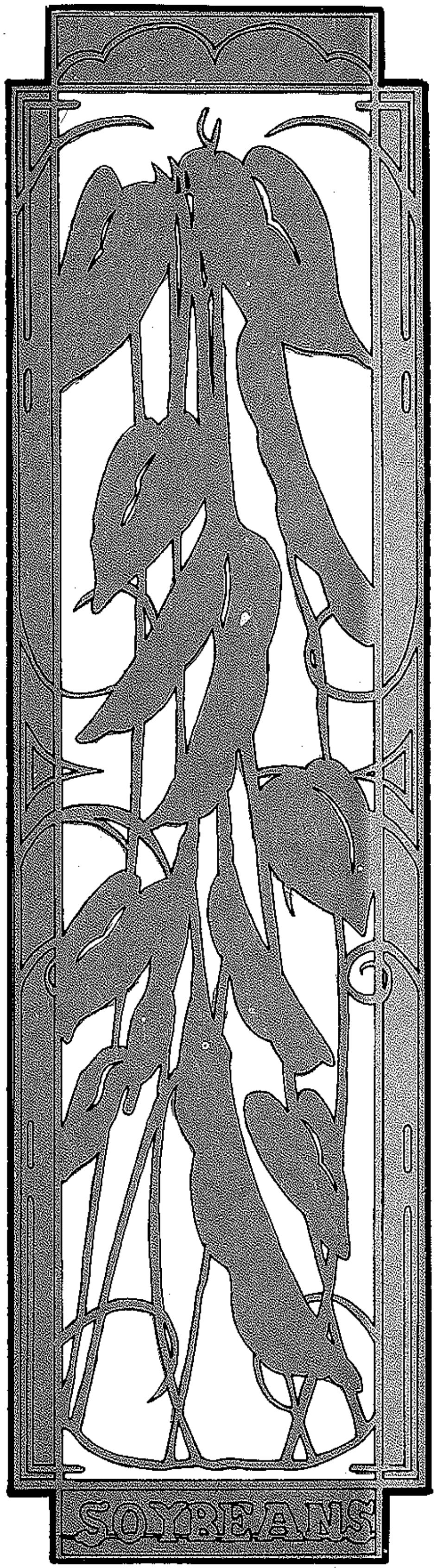

SOYBEAN Response to Tillage of Sharkey Clay Soil

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Summary

Mack, Tracy and Bragg Soybeans were grown on a Sharkey clay in 40-, 30- and 20-inch rows for three years on plots subsoiled 18-20 inches deep with a curved-shank subsoiler, deep-chisel plowed 12 inches deep or shallow-chisel plowed 6 inches deep. A disk only treatment was compared with the other tillage methods in the third year. Data from the trials indicate that shallow tillage results in yields equal to those resulting from deep tillage and is, therefore, preferable to deep tillage because of lower costs and reduced energy requirements.

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Clay soils (Alligator, Dowling, Sharkey and unclassified) account for more than one half of the land area of the Yazoo-Mississippi Delta (7). Almost 10% of the soils are in the Sharkey series (montmorillonitic, Vertic Haplaquept), and 7.62% of the soils of the Delta of Mississippi are Sharkey clay. All clay soils are well suited for soybean production because of their high fertility and topographic position.

Sharkey clay has slow internal drainage and high water-holding capacity. Also, montmorillonitic clays predominate in the clay fraction and give the soil a high degree of shrink-swell potential upon drying and wetting (1). Soils that shrink and swell develop cracks or continuous pores of low root impedance or low soil strength (5,8), and roots growing in and through these natural cracks display a flattened appearance (13).

Deep tillage usually has increased crop yields only when water intake(and/or root penetration)has been limited by restrictive layers in the soil profile (4, 6, 8, 10, 11, 12). Soil strength usually is the factor that restricts root penetration through the pan formations (3, 8, 9, 10). Deep tillage reduces soil strength and root impedance in these zones. Time of tillage can affect yield response to the disruption of these soils (12) but may not increase yields if periods of drought stress are avoided by irrigation or adequate and timely rainfall, because plants are less dependent on moisture below the impervious layer (6,10).

Response to profile modification of soils with a high percentage of montmorillonitic clay has been varied. Cotton root penetration into the subsoil was altered only slightly by degree of compaction of a Mhoon clay loam (5). Severe mechanical disruption of the profile to 24 and 48 inches improved aeration and increased yields of cotton and grain sorghum on a deep, slowly permeable Houston black clay (2), but the tillage was so severe that many years of residual effect would be required for the procedure to return more than it costs.

This study was conducted to determine the effect of various types and depths of tillage and various row spacings on the yield of Mack, Tracy and Bragg soybeans grown on Sharkey clay soil.

Procedure

The three-year study was conducted on a Sharkey clay soil at the MAFES Delta Branch. Bulk density of the soil at all depths was well below the 1.6 g/cm³ (Table 1) reported by Zimmerman and Kardos (13) as the value at which soybean root penetration was severely restricted in a shrink-swell soil. All nutrient levels were high or very high at the beginning and at the end of the study.

Table 1. Properties of the Sharkey clay soil used in a study of the effects of various types and depths of tillage on the yield of soybeans, Stoneville, Mississippi.

Soil depth	Mineral fractions[1]			Organic matter	Bulk density	pH	Nutrient analysis			
	Sand	Silt	Clay				P	K	Mg	Ca
Inches	%				g/cm³		lb/acre			
0.12	4	33	63	1.01	1.21	6.9	90	870	3170	13160
12.24	6	44	50	1.07	1.35	7.3	100	680	2645	11900
24-36	6	30	64	1.79	1.33	7.6	90	635	3570	13650
36-48	6	28	66	1.64	1.32	7.3	110	700	3925	13280

[1] Sand = > 0.05 mm diameter; silt = 0.002-0.05 mm diameter; clay = < 0.002 mm diameter.

1976 Trials

Plots were tilled on March 1 by (1) subsoiling 18-20 inches deep with a curved-shank subsoiler ("S") on 40-inch centers perpendicular to row direction, (2) by deep-chisel plowing ("DC") 12 inches deep on 20-inch centers perpendicular to row direction or (3) by shallow-chisel plowing ("SC") 6 inches deep on 20-inch centers perpendicular to row direction. Trifluralin was applied and disk incorporated on March 3.

The experiment was designed as a complete block with three replicates of treatments in a split-split plot arrangement. Tillage treatments were randomized within replicates, row spacings were randomized within tillage treatments, and varieties were randomized within row spacings. All tillage treatments were separated by 15-ft wide alleys.

Plots were planted May 21 with Mack, Tracy and Bragg soybeans at rates of 12 seed/row ft on 40-inch wide rows, nine seed/row ft on 30-inch wide rows and six seed/row ft on 20-inch wide rows. All rows were 30 ft long.

All plots were treated preemergence with a tank-mix of alachlor and linuron. The 40-inch wide rows were cultivated twice, and the 30- and 20-inch wide rows were hoed once by hand.

Moisture in the soil of each plot was measured throughout the growing season by neutron attenuation. All measurements were on dates preceded by seven or more days with no rainfall. One access tube was located in one drill row of each plot.

Plant height measurements and lodging scores were recorded for each plot, and all plants on 2.5 ft of each end of each row were removed before harvesting Mack on October 4 and Tracy and Bragg on November 3. A combine modified for use on small plots was used to harvest two 40-inch wide rows, three 30-inch wide rows and four 20-inch wide rows from all replicates of each row spacing, and weights of harvested seed were converted to bu/acre at 13% moisture. Also, weights of two 100-seed samples per plot were recorded.

1977 Trials

Tillage was delayed until May 10 because of wet soil. The test site used in 1976 (designated 1977A) and another site with a history of shallow tillage only (1977B) were prepared by the methods used in 1976. Trifluralin was applied and disk incorporated on April 13.

The experimental design of 1977A was the same as in 1976. The 1977B trial was replicated two times, and only the 40- and 20-inch row spacings were used.

All plots were planted on June 21, and the 40-inch wide rows were cultivated once. Mack was harvested on October 18, Tracy and Bragg on November 15.

All other procedures were the same as in 1976.

1978 Trials

The original test site was tilled on April 3. A disk-only ("D") treatment was added to the three tillage treatments used in the previous two years, and only 40- and 20-inch row spacings were used. The varieties and experimental design were the same as in 1976.

The 40-inch rows were cultivated twice, and the 20-inch rows were hoed once by hand. Mack was harvested on October 11, Tracy and Bragg on October 30. All other procedures were the same as in 1976.

Results and Discussion

Rainfall from time of planting through October 1 measured 13.8, 10.0 and 15.2 inches in 1976, 1977 and 1978, respectively (Table 2). Eight of the 15.2 inches in 1978 were in the first two weeks after planting.

Depth of tillage did not alter soybean rooting depth significantly as determined by moisture content of the soil. Moisture content of the soil at each sample depth in 1976 was slightly higher in plots tilled with the curved-shank subsoiler than in plots tilled by the other methods (Table 3). The same relationship was found in 1977, but to a lesser extent, and was absent in 1978. Water was extracted from all measured depths of each tillage treatment in all years.

Yield differences among the three tillage treatments were not significant in any year, and differences in yields among the three row spacings were significant only in 1977, the year when planting was delayed until June 21 (Table 4). The inconsistent differences in yield among

Table 2. Average temperature, rainfall and pan evaporation in 1976, 1977 and 1978, by time periods, Stoneville, Mississippi.

Time period	1976 Average temp max	1976 Average temp min	1976 Rain-fall	1976 Pan evap	1977 Average temp max	1977 Average temp min	1977 Rain-fall	1977 Pan evap	1978 Average temp max	1978 Average temp min	1978 Rain-fall	1978 Pan evap
	-----°F-----		----in.----		-----°F-----		----in.----		-----°F-----		----in.----	
May 1-15	75	54	1.77	3.09	84	62	0.43	4.33	75	57	9.84	3.34
May 16-31	78	58	1.50	3.39	91	66	0.63	5.33	87	66	2.05	3.78
June 1-15	86	66	0.83	4.09	93	68	1.10	5.09	85	66	6.77	3.45
June 16-30	86	68	5.16	3.29	92	74	1.34	4.57	94	74	0.20	4.49
July 1-15	88	69	3.15	3.58	94	73	2.91	4.53	96	75	0.75	4.70
July 16-31	93	71	0.47	4.34	91	72	0.79	3.29	93	72	0.04	4.84
Aug. 1-15	91	67	0.04	4.13	91	71	0.12	3.96	90	70	3.07	3.71
Aug. 16-31	92	67	0.24	3.94	91	71	0.75	3.69	92	70	1.54	4.08
Sept. 1-15	84	63	1.77	2.75	90	69	2.09	3.46	88	68	1.46	2.41
Sept. 16-30	84	61	1.06	2.53	86	66	2.80	2.63	85	65	0.55	2.52
Oct. 1-15	78	51	0.83	2.21	74	50	2.32	2.61	78	49	0.67	2.66
Oct. 16-31	63	42	2.99	1.56	76	49	0.59	2.14	77	46	0.24	2.61

Table 3. Volumetric soil water content of the Sharkey clay soil used in a study of the effects of various types and depths of tillage on the yield of soybeans, by sample depth, year and tillage method, Stoneville, Mississippi, 1976-1978.

Soil Depth	1976 S[1]	1976 DC[2]	1976 SC[3]	1977 S[1]	1977 DC[2]	1977 SC[3]	1978 S[1]	1978 DC[2]	1978 D[4]	1978 SC[3]
	%/vol									
(in.)	Day 54[5] - July 14			Day 27 - July 18			Day 34 - June 27			
12	51.6	47.7	46.6	51.8	52.1	50.4	54.0	52.8	52.3	51.6
24	54.6	52.6	51.7	53.1	52.5	50.8	51.8	52.7	52.1	51.2
36	53.8	52.1	52.6	51.8	51.8	51.2	51.8	51.8	52.0	51.1
48	55.9	54.3	54.5	53.2	53.5	52.5	52.2	52.5	53.0	52.0
	Day 74 - August 3			Day 49 - August 9			Day 65 - July 28			
12	39.7	38.1	36.5	43.7	42.9	40.9	40.8	39.0	40.1	42.4
24	43.4	42.4	39.7	45.0	43.9	42.1	41.7	41.8	41.0	41.6
36	52.2	51.9	51.2	51.4	51.9	51.0	45.4	46.7	45.8	44.5
48	54.3	54.2	53.9	53.4	53.4	53.0	51.8	52.1	51.9	51.5
	Day 98 - August 27			Day 59 - August 19			Day 105 - Sept. 6			
12	34.0	30.1	29.1	40.8	39.9	36.6	40.4	39.2	41.4	42.2
24	39.5	37.1	35.6	41.7	40.3	37.8	42.1	39.8	41.5	41.5
36	42.2	41.8	39.9	47.8	47.2	46.6	44.1	42.7	43.3	43.2
48	51.7	52.1	47.2	52.4	52.8	52.0	48.5	49.1	48.0	49.6
	Day 117 - Sept. 15			Day 78 - Sept. 7			Day 121 - Sept. 22			
12	42.5	37.1	34.2	37.2	36.6	32.0	41.6	41.2	42.9	43.3
24	43.3	39.1	36.2	39.3	38.0	34.2	41.4	39.7	41.2	41.5
36	44.0	41.5	40.7	41.2	40.5	39.7	42.2	41.9	42.7	43.0
48	48.9	49.6	46.2	46.9	46.5	45.9	48.2	47.9	47.4	48.9

[1]S = Subsoiled 18 to 20 inches deep with a curved-shank subsoiler on 40-inch centers perpendicular to row direction

[2]DC = Deep-chisel plowed 12 inches deep on 20-inch centers perpendicular to row direction

[3]SC = Shallow-chisel plowed 6 inches deep on 20-inch centers perpendicular to row direction

[4]D = Disk only

[5]Day number = days after planting

varieties among years was attributed to timeliness of rainfall relative to the reproductive stages of the three varieties. Late planting and the low rainfall during the growing season appeared to be the major cause of the lower yields in 1977.

The only significant difference in seed weight among tillage treatments was in 1978 when the plots tilled by shallow-chisel plowing produced seed of lower weight. Some differences in seed weight among row spacings were significant, but the differences in seed weight did not appear to be related to the yield differences among row spacings.

Plant height did not differ significantly ($P<.05$) among tillage methods in 1976, 1977A and 1978 (Tables 5, 6 and 8). Narrowing the rows tended to cause shorter plants in 1977A and 1978 (Tables 6 and 8). Plant height in 1977B was affected ($P<.05$) by the interaction of tillage methods and row spacings (Table 7).

Height of Tracy and Bragg plants in 1976 was less ($P<.05$) on the 20-inch rows than on the 30- and 40-inch rows (Table 5). Differences in plant height in each trial followed the significant trend to taller plants with increased length of the growing season.

Lodging ratings are reported only for 1976 and 1977A (Table 9) when enough lodging occurred to make harvesting difficult.

Table 4. Seed yield and weight of 100 seed of soybeans grown on a Sharkey clay soil, by tillage method, row spacing, variety and year, Stoneville, Mississippi.

	Grain yield				Weight of 100 seed			
Item	1976	1977A[5]	1977B[6]	1978	1976	1977A[5]	1977B[6]	1978
	------------bu/acre----------------				------------------g------------------			
Tillage								
S[1]	28.0 a[7]	22.8 a	22.5 a	28.2 a	14.1 a	14.9 a	14.7 a	14.4 a
DC[2]	28.5 a	22.9 a	22.3 a	28.5 a	14.2 a	14.8 a	14.9 a	14.2 a
SC[3]	27.8 a	23.0 a	21.7 a	28.2 a	14.2 a	14.8 a	14.7 a	13.7 b
D[4]	------	------	------	30.7 a	------	------	------	14.2 a
Row Spacing								
40 in.	28.2 a	21.8 b	21.2 b	29.2 a	14.0 c	14.8 a	15.0 a	14.3 a
30 in.	27.7 a	22.5 b	------	------	14.2 b	15.0 a	------	------
20 in.	29.0 a	24.4 a	23.1 a	28.6 a	14.6 a	14.7 a	14.5 b	14.0 b
Variety								
Mack	24.2 b	23.5 a	22.3 ab	29.0 a	11.6 c	13.3 c	13.3 c	14.0 b
Tracy	30.1 a	21.8 b	20.6 b	28.1 a	15.8 a	16.8 a	16.8 a	14.7 a
Bragg	30.6 a	23.3 a	23.6 a	29.5 a	15.3 b	14.4 b	14.2 b	13.7 b

[1,2,3,4]See Footnotes, Table 3.

[5]Same test area and experimental design as in 1976.

[6]Test conducted on a similar soil with a history of shallow tillage only.

[7]Values within each column for each item followed by the same letter did not differ ($P < .05$) according to Waller-Duncan k-ratio t-test (k-ratio = 100).

Table 5. Mature plant height of soybeans grown on a Sharkey clay soil by tillage method, row spacing and variety, Stoneville, Mississippi, 1976.

Item	Variety	Plant Height
		inches
Tillage		
S[1]		34.7a[4]
DC[2]		35.3a
SC[3]		34.6a
Row Spacing		
40 inches	Mack	32.0d[5]
	Tracy	34.8c
	Bragg	40.8a
30 inches	Mack	31.5d
	Tracy	34.2c
	Bragg	40.1a
20 inches	Mack	32.4d
	Tracy	32.8d
	Bragg	38.4b

[1,2,3]See footnotes, Table 3.

[4]Main effect means and [5] interaction means followed by the same letter did not differ (P<.05).

Table 6. Mature plant height of soybeans grown on a Sharkey clay soil, by tillage method, row spacing and variety, Stoneville, Mississippi, 1977A.[1]

Item	Plant Height
	inches
Tillage	
S[2]	35.5a[5]
DC[3]	37.0a
SC[4]	35.3a
Row Spacing	
40 inch	37.1a
30 inch	35.3a
20 inch	35.4a
Variety	
Mack	34.3b
Tracy	35.0b
Bragg	38.5a

[1]Same test site as used in 1976.

[2,3,4]See footnotes, Table 3.

[5]Means within each item followed by the same letter did not differ (P < .05).

Table 7. Mature plant height of soybeans grown on a Sharkey clay soil, by tillage method, row spacing and variety, Stoneville, Mississippi, 1977B.[1]

Item		Plant Height
		inches
Tillage	Row spacing	
S[2]	40 inches	28.3abc[5]
	20 inches	30.3a
DC[3]	40 inches	30.6a
	20 inches	27.8bc
SC[4]	40 inches	29.1ab
	20 inches	26.6c
Variety		
Mack		25.2c[6]
Tracy		28.3b
Bragg		32.9a

[1]Trial conducted on a Sharkey clay soil with a history of shallow tillage only.

[2,3,4]See footnotes, Table 3.

[5]Interaction means and [6] main effect means followed by the same letter did not differ (P < .05).

Table 8. Mature plant height of soybeans grown on a Sharkey clay soil, by tillage method, row spacing and variety, Stoneville, Mississippi, 1978.[1]

Item	Plant Height
	inches
Tillage	
S[2]	29.4a[6]
DC[3]	29.4a
SC[5]	28.5a
D[4]	30.1a
Row Spacing	
40 inch	30.8a
20 inch	27.9b
Variety	
Mack	20.7c
Tracy	32.0b
Bragg	35.3a

[1]Same test site as used in 1976 and 1977A.

[2,3,4,5]See footnotes, Table 3.

[6]Means within each item followed by the same letter did not differ (P < .05).

Table 9. Lodging scores of soybeans grown on a Sharkey clay soil, by tillage method, row spacing and variety, Stoneville, Mississippi, 1976 and 1977A.

Tillage	Row spacing	Lodging score[1] 1976	Lodging score[1] 1977A	Tillage	Variety	Lodging score 1976	Lodging score 1977A	Row spacing	Variety	Lodging score 1976	Lodging score 1977A
	(in.)	---- 1-5 ----				---- 1-5 ----		(in.)		---- 1-5 ----	
S[2]	20	3.4 a[5]	3.2 abc	S[2]	Mack	2.4 b	1.7 c	40	Mack	2.5 cd	2.8 d
	30	2.1 c	2.8 cd		Tracy	2.5 b	3.3 a		Tracy	3.9 a	3.8 a
	20	2.3 c	2.7 cd		Bragg	2.9 a	3.7 a		Bragg	4.0 a	3.8 a
DC[3]	40	3.2 a	3.6 a	DC[3]	Mack	2.2 b	2.6 b	30	Mack	2.1 d	1.8 e
	30	3.0 a	2.9 bc		Tracy	3.1 a	3.6 a		Tracy	3.1 b	3.3 bc
	20	2.4 bc	3.3 ab		Bragg	3.2 a	3.7 a		Bragg	3.2 b	3.4 abc
SC[4]	40	3.4 a	3.6 a	SC[4]	Mack	2.2 b	1.9 c	20	Mack	2.4 cd	1.7 e
	30	2.9 ab	2.8 cd		Tracy	3.2 a	3.3 a		Tracy	2.7 c	3.0 cd
	20	2.4 bc	2.4 d		Bragg	3.2 a	3.5 a		Bragg	3.2 b	3.7 ab

[1]1 = almost all plants erect; 2 = all plant leaning slightly, or some plants down; 3 = all plants leaning moderately, or 25 to 50% of plants down; 4 = all plants leaning considerably, or 50 to 80% of plants down; 5 = all plants down.

[2,3,4]See footnotes, Table 3.

[5]Means in each column followed by the same letter did not differ (P < .05).

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