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An experiment was conducted on a 2-5% sloping Mercer silt loam soil on a farm in Bourbon/Harrison Counties where very poor corn was grown in 1984 because of soil compaction and drought. Soil test levels of the experimental area were: pH 4.8, and 99, 316, 2070, and 120 lbs/A of P, K, Ca, and Mg, respectively. Examination of the field showed that the compacted zone occurred uniformly in the 0-5 inch surface layer of soil. Cause of this compacted layer was thought to be due to excessive disk tillage in prior years when preparing the field for tobacco production and to winter grazing of a wheat cover crop. The objective of the experiment was to evaluate the influence of fall or spring plowing with a paraplow, chisel plow, or moldboard plow on plowsole bulk density and corn production.

Experimental Procedures

The experiment consisted of testing a 3-shank, 20-inch centered paraplow, a twisted-shank 12-inch centered chisel plow, and a 3-bottom moldboard plow for fall (Oct. 2, 1984) and spring (April 2, 1985) primary tillage, followed by spring disking just prior to planting corn (May 10, 1985). A v-ripper was also tested for fall tillage. The control treatment consisted of untilled soil. Plots were strips 25 ft wide and 200 ft long. Each plot was divided into 4, 50 ft subplots for use in making bulk density and corn yield measurements. Corn (var. Pioneer Brand 3320) was no-till planted in 36-inch rows (May 10, 1985) with a 2-row John Deere plateless no-till planter at a setting of 23,800 seeds per acre. Herbicides used were a tank mixture of 1.5 pints Paraquat, 1.5 lbs Atrazine, 2.5 lbs Lasso, X-77 surfactant, and 40 gallons water per acre. Soil bulk density of the 0-5 inch layer was measured in place from the 16 subplots of the fall tillage treatments prior to tillage (Oct. 2, 1984) and again after corn was physiologically mature (Aug. 28, 1985). A displacement method of measuring soil bulk density in place was used in which a hole of approximately 1 quart volume was carefully dug to a depth of 5 inches. All the soil dug from the hole was carefully collected, oven-dried (107°C) and weighed. Volume of the hole was measured by inserting a thin-walled rubber balloon into the hole, filling it with water until it exactly conformed to the shape of the hole, and then measuring the volume of water. Soil penetrometer measurements were also taken when the corn was about 12-inches tall (June 7, 1985) and again when in place bulk density was measured on August 28, 1985. Corn yields were estimated from each 16 row 50-ft subplot (September 30, 1985) by harvesting 15 ft from each of the three center rows for grain. Total dry matter yield was estimated by

randomly cutting and weighing 10 whole plants from rows near the grain harvest area, determining moisture content, calculating dry weight per plant and adjusting to an acre basis by multiplying by plant population. Silage yields were estimated by converting total dry matter yield to a 65% moisture basis.

Results

As shown in Table 1, the control treatment of no-till planting into untilled soil produced surprisingly high grain yields (115 bu/A), particularly in view of the limited size of the stalks, which was reflected in the low silage yield (8.2 T/A). The high grain yield from the control treatment was probably due to very good rainfall in July and August during grain fill. Grain yields from fall tillage with the chisel plow and v-ripper were no better than the no-till control treatment. This was probably due to these tools not completely shattering the compacted layer (evidenced by the 4 to 6 inch penetrometer readings of June 7) and to overwinter settling. Fall paraplow and moldboard plow treatments increased yields over the control. Grain yields were best from the spring moldboard and chisel plow treatments. Spring paraplow yields were about the same as from the fall paraplow treatment.

The effect of fall plowing on soil bulk density and soil resistance measurements is shown in Table 2. There was very little difference in moisture content of soil among treatments when bulk density was measured. Bulk density represents the weight of soil per unit volume of soil and thereby is a good index of soil compaction. It is generally considered that soil bulk densities greater than 1.4 grams per cubic centimeter restricts root penetration. The reason bulk density was lower in the untilled control treatment in August 1985 than in October 1984 was probably due to (1) soil was not as shrunken during 1985 because of more moisture, and (2) more root penetration in 1985 because of better moisture (in 1984 roots did not grow out of the furrow opener slit). Although soil penetrometer measurements were not made prior to fall tillage in October 1983, readings taken from the control plot would indicate that initial resistance would have been near 300 lbs/sq. in. It is generally considered that soil resistance in excess of 200 p.s.i. will inhibit root growth. The August 23, 1985, readings indicate that all fall tillage plots had settled to levels in excess of 200 p.s.i. The fall paraplow plots had settled considerably less than the other fall plowed plots. June 7 readings, taken 4 weeks after planting showed the fall moldboard plowed treatment to have considerably lower 0-6 inch resistance than the other fall plowed treatments. A more detailed summary of soil penetrometer readings taken on June 7, 1985, 4 weeks after the corn was planted is shown in Tables 3 and 4.

Conclusions

All tillage treatments tested except fall chisel plowing and fall v-ripping improved corn yields over the control treatment, despite the control treatment yielding well under severely compacted conditions. The high yield from the control treatment was probably due to very favorable rainfall distribution during July and August which greatly improved root growth during 1984, although it was still confined to the top 3 inches of soil. Moldboard and chisel plowing in the spring resulted in highest yields. Paraplowing in the fall was equal to moldboard plowing in the fall, but not as good as spring moldboard plowing. Under the soil and climatic conditions from October 1984 to October 1985 where the compacted zone was in the surface 5 inches, spring moldboard plowing produced the most grain. Total dry matter production (silage) was nearly the same for the paraplow and the moldboard plow, fall or spring plowed.

Table 1. Corn Yield (Av. of 4 subplots per strip) as Influence by Tillage Treatments

Tillage Treatment	Grain Yield		Silage Yield	
	Fall Plow	Spring Plow	Fall Plow	Spring Plow
	---Bu/A---		---T/A---	
Paraplow, spring disk	128	125	14.7	15.7
Paraplow, not disked	124	-	9.3	-
Chisel plow, spring disk	116	131	11.6	11.2
Moldboard plow, spring disk	128	136	14.2	15.2
V-ripper, spring disk	117	-	12.4	-
Control (no-till in untilled soil)	- 115 -		- 8.2 -	

Table 2. Soil Resistance and Density Levels of the Compacted Layer of Fall-Tilled Plots.

Treatment	Soil Resistance*		In-Situ Soil Bulk Density*	
	June 7, 1985	Aug. 23, 1985	Oct. 1984	Aug. 23, 1985
	---p.s.i.**---		---g/cc---	
Fall paraplow spring disk	198	207	1.47	1.17
Fall chisel spring disk	200	243	1.52	1.17
Fall moldboard spring disk	149	251	1.48	1.19
Fall v-ripper spring disk	203	290	1.48	1.23
Control (untilled)	293	292	1.49***	1.37

* There was little difference in moisture content when treatments were sampled. Moisture content was 15-16% in October 1984, 20-22% on June 7, 1985, and 17-19% on August 23, 1985.

** Maximum resistance (lbs/sq. in.), 0-6 inch (readings for 300+ were counted as 300).

*** Av. for all plots before any tillage was done.

Table 3. Soil Resistance on June 7, 1985 at Different Soil Depths.

Treatment	Soil Depth 0-2 inches	2-4 inches	4-6 inches
	p.s.i.		
Fall paraplow-spring disk	93	161	198
Fall chisel plow-spring disk	83	141	200
Fall moldboard plow-spring disk	87	129	149
Fall v-ripper-spring disk	47	119	203
Control: Not plowed, not disked	274	297	293
Fall paraplow-not disked	105	150	193
Spring chisel plow-spring disk	38	132	218
Spring moldboard plow-spring disk	34	83	172
Spring paraplow-spring disk	78	167	209
Not plowed-spring disk	26	122	231

[1] Av. of 12 penetrometer readings taken over 200 ft of plot (readings of 300+ were counted as 300).

Table 4. Effect of Spring or Fall Plowing Followed by Spring Disking on Maximum Soil Resistance (June 7, 1985).

Depth (inches)	Paraplow		Chisel Plow		Moldboard Plow		Control
	Fall	Spring	Fall	Spring	Fall	Spring	Not Plowed or Disked
	p.s.i.						
0-2	93	78	83	38	87	34	274
2-4	161	167	141	132	129	83	297
4-6	198	209	200	218	149	172	293

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