INFLUENCE OF PRIMARY TILLAGE ON COMPACTNESS OF BLACK BELT SOILS

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No-till and reduced tillage systems that leave more surface residue are generally useful in reducing erosion, but are not universal in their impact on crop yields. No-till yields have been reported that range from better than conventional tillage to total crop failure. The nearly level, dark, poorly drained soils of Ohio, Indiana, and Illinois, for example, are similar to soils in the Black Belt and frequently produce lower yields when residues are left on the surface rather than turned under by conventional tillage (SCSA, 1974).

Jones et al. (1941) and Leonard (1945) studied tillage in the Black Belt during the 1930's and 1940's and concluded that looseness was necessary in the surface soil to promote abundant root growth. Many soils, including those of the Black Belt, have been overworked in the past. The general belief today is that soil needs to be tilled just enough to assure optimum crop production and weed control. Many fine textured soils, such as those of the Black Belt, may require a finite amount of tillage to provide adequate aeration and reduce compaction caused by equipment or raindrop impact.

Our objective was to determine how soil strength and surface soil compaction is influenced by tillage intensity on two Black Belt soils.

Materials and Methods

A base crop of soybeans was established on Okolona silty clay and Leeper silty clay loam soils in the Black Belt in 1980. During the following three years, soybeans were grown under four monocrop tillage systems and one soybean-wheat doublecrop system. The monocrop systems were defined as: conventional spring chisel plus fall chisel plowing (CT+), conventional spring chisel only (CT), zero-till planting plus cultivation (MIN), and zero-till planting with no cultivation (NO-TILL). Both conventional systems received secondary tillage in the form of disking and/or harrowing to prepare the seedbed. In the doublecrop treatment both wheat and soybeans were zero-till planted. Wheat straw was burned prior to planting soybeans and the soybeans were cultivated twice. Monocrop soybeans were usually planted the third week in May and doublecrop soybeans were usually planted by mid-June.

Penetrometer readings were taken in conjunction with soil moisture readings during the second week of July in 1981. No readings were taken during 1982. In mid-April of 1983 penetrometer readings were taken on the

Okolona soil in conjunction with soil moisture and bulk density measurements. Penetrometer readings were taken in the Leeper soil in mid-April of 1984. The 1983 and 1984 readings were taken prior to any spring tillage operations and while soil moisture was relatively uniform among the tillage treatments. All penetrometer and bulk density measurements were taken in row middles where wheel traffic had little affect.

Analysis of variance and regression analyses were used to make statistical comparisons.

Results and Discussion

The response of both soils was similar. Primary tillage provided only a temporary (one season or less) modification of such soil conditions as soil strength (penetrometer resistance) and compaction (bulk density). Soil strength in mid-July of 1981 was sensitive to water content as well as bulk density, and was negatively correlated to plant height and yield on the Leeper soil (see table below).

Regression Analyses - 1981

Penetrometer resistance (P.R.) regressed with:	Regression equation	r^2
Bulk density (D_B)	Y = 1.14 + .002X	.670[1/]
Water content (P_v)	Y = 37.62 - .1245X	.780
Plant height (Leeper soil)	Y = 54.3 - .053X	.433
Yield (Leeper soil)	Y = 42.3 - .062X	.373
Yield (Okolona soil)	Y = 24.5 - .0094X	.062

1/Values >.332 or >.501 are significant at the .05 and .01 level of probability, respectively.

Penetrometer readings taken in mid-July of 1981 (data not shown) indicated that soil strength was significantly greater in minimum and no-till plots than in conventional tillage plots, especially at the 3-inch depth. The Okolona soil was harder to penetrate in 1981, even at a higher volumetric water content. Penetrometer readings taken in mid-April of 1983 on the Okolona soil and mid-April of 1984 on the Leeper soil reflect the inability of these soils to ameliorate soil strength through natural forces associated with the shrinking and swelling characteristics of the soils (see table below).

Means for Penetrometer Resistance (P.R.), Bulk Density (DB) and Volumetric Water Content (P_v) by Tillage Treatment

Tillage Treatment	Soil[1/] Okolona[2/] P.R. kg/cm^2	D_B g/cm^3	P'' cm^3/cm^3	Leeper[3/] P.R. kg/cm^2	D_B g/cm^3	P_v cm^3/cm^3
CT+	4.50 a[4/]	1.29 a	.46	4.92 a	1.39	.30
CT	6.89 b	1.38 b	.44	7.52 b	1.40	.30
MIN	7.03 b	1.36 b	.42	7.73 b	1.44	.30
NO-TILL	8.09 c	1.30 b	.42	0.06 c	.44	.30
DUO	8.09 c	1.36 b	.41	9.98 d	1.38	.26

[1/] Values reported for 3-inch depth.
[2/] Measurements made mid-April, 1983.
[3/] Measurements made mid-April, 1984.
[4/] Means within a column followed by same letter are not significantly different at the 5% level of probability (DMRT).

The no-till system therefore results in greater compactness in the surface soil as reflected in resistance to penetration. Potential consequences include lower hydraulic conductivity, poor aeration, uneven germination, and undesirable environment for early root growth. Penetrometer resistance more accurately reflected differences in soil strength and gave greater differences among the tillage systems than did bulk density, especially in the Leeper soil. However, bulk densities taken six months or longer after primary tillage were in the 1.36 to 1.44 g/cm^3 range. According to Jones (1983) bulk density should be about 1.2 g/cm^3 for ideal root growth on soils of this texture. His data also indicate that with a bulk density of 1.45 g/cm^3 root growth is only two-tenths of normal. If this is the case, most Black Belt soils need tillage every spring for optimum crop yields.

Data presented elsewhere in these proceedings (Sanford et al.) showed no-till doublecrop soybeans-wheat was the most productive of five tillage systems in the Black Belt over a three year period. However, no-till monocrop soybeans in the same study yielded significantly below conventional chisel plowed soybeans.

Literature Cited

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