Subsoil Shattering and Subsoil Liming for Crop Production on Claypan Soils*

C. M. Woodruff and D. D. Smith

The claypan soils represent a large area of relatively level agricultural land throughout the central states region. They are characterized by poor internal profile drainage and a low level of fertility. Although relatively level and not subject to excessive erosion, these soils are considered dry and unsuited to the growth of cultivated row crops, such as corn.

Numerous studies have been made on the improvement of these soils through deep tillage, tile drainage, and deep placement of fertilizer (3). Evidence obtained from recent studies and experiments suggests that a solution is being obtained to the problem of growing corn on these soils.

The problems of soil management on claypan soils provoked this project initially under the leadership of Miller, et al. (2) and received their first physico-chemical attack from Bradfield (1).

The design of the experiment for which the data are reported in this paper was prompted by some studies which showed that in the claypan horizon the pore space of the soil is filled with water at a moisture tension represented by the field capacity (5). These studies also showed that the clay when immersed in water reaches a limited degree of hydration of about 40% moisture by weight. The unworkable plastic condition of the clay was observed to disappear and to be replaced by a stable granular condition during periods of drought when legume crops, such as sweetclover, lespedeza, and soybeans, occupied the land. While in this semi-dry condition the claypan is susceptible to shattering by deep tillage. These observations and facts suggested that if the clay were shattered mechanically while in a semi-dry condition the water-holding capacity and the aeration of the soil should be improved.

In addition to the undesirable physical characteristics associated with the subsoil horizon of the claypan soils, chemical studies reported by Whiteside and Marshall (4) showed that the soil layers beneath the surface plow depth were less than 50% saturated with exchangeable bases. Lime must be added to correct this acid condition of the subsoil. Unreported data from the Missouri Experiment Station show that lime and fertilizer injected into the subsoil through a tube on the rear of a Killefer pan breaker remained unweathered for a period of 10 years in a small band at the bottom of the silt cut by the deep tillage machine. These results suggested that the lime should be well distributed through the subsoil in order to be effective.

The experiment reported in this paper, consists of 27 field plots in three ranges of 9 plots each, were limed at 3 tons per acre, fertilized with 0-20-10 fertilizer on each small grain crop, and a 3-year rotation of corn, oats with lespedeza, and barley with sweetclover in which both the lespedeza and barley were used as green manure crops. All crops were present each year. Three conditions, namely, (a) plowed normally without disturbing the subsoil; (b) plowed normally followed by plowing through a furrow or shattering the subsoil; and (c) plowed only 2 tons limestone and 200 pounds of 8-20-10 with the subsoil.

The cropping system was selected with the following features: (a) With lespedeza as the summer legume to dehydrate the subsoil during a period of low moisture conditions; (b) plowing and shattering, and (c) with sweetcorn as a source of nitrogen for the corn.

Subsoil shattering was accomplished in the spring by dual plowing. The first plow, an 18-inch drawn plow, turned the soil to a depth of 16 to 20 inches. Following in the furrow behind the first plow was a 12-inch walking plow which attained a total depth of 16 to 20 inches below the surface. The second plow was small enough so that the clay was not thrown out of the furrow, but fell back into the furrow with a minimum of mixing with the surface soil. The lime and fertilizer were incorporated by scattering the mixture by hand over the surface of the plot. The slippage of the right side of the tractor drawing the first plow then mixed the material thoroughly with the dry shattered clay as the tractor moved along in turning the next furrow. The original unplated resharding of the subsoil at the end of the 3 years of the study.

DATA AND RESULTS

The data, results, and observations recorded on yields, soil moisture studies, observations on the resistance of the corn crop, and root development in the various crops.

SOIL MOISTURE STUDIES

Triplicate samples of soil to a depth representing the depth of shattering, were drawn from the plots in corn from each of the three treatments giving nine samples of each of the three treatments. The results for the period May 30, 1943, to July 26, 1944, while corn was growing and when moisture became deficient, are reported in Table I. Since 1% of moisture corresponds to 0.27 inch of water as rainfall in the 18-inch depth, any increase of 2.3% in the shattered plot corresponds to 0.62 inch of rain. This increase cannot be considered to be great enough to influence the results recorded in Table I.

Numerous studies have been made on the improvement of these soils through deep tillage, tile drainage, and deep placement of fertilizer (3). Evidence obtained from recent studies and experiments suggests that a solution is being obtained to the problem of growing corn on these soils.