EFFECT OF CROP AND SURFACE MULCHES ON RUNOFF, SOIL LOSSES, AND SOIL AGGREGATION

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IN RECENT YEARS the effect of cropping systems and surface mulches on infiltration, runoff, soil loss, and soil structure have received considerable attention. It is generally recognized that different cropping systems do affect soil structure differently. It also has been definitely established that surface mulches of plant material are very effective in reducing soil and surface water losses. However, many problems relating to the practical application of stubble mulch culture are still unsolved. Further study is also needed on the specific effects of the continued use of surface mulches on the soil, particularly on soil structure. Although many general principles have been established, specific results may vary considerably depending upon the kind of mulch, kind of crop grown, tillage practices, soil type, and climatic conditions.

Musgrave (9) has called attention to the importance of rainfall penetration to crop production. Browning (2) discussed many changes in erodibility of soils which are brought about by the application of organic matter. Hendrickson (6), Borst and Woodburn (1), Duley (4), Musgrave (9), and Kidder, et al. (7) emphasized that raindrops falling on exposed soil compact the surface and clog the pores of the soil at the surface with fine soil particles. This compaction and clogging reduces the permeability of the surface layer and may result in relatively low infiltration on some otherwise well-aggregated soils. Such a condition is brought about when the surface of the soil is unprotected from the impact of falling raindrops by a mulch or by the canopy furnished by a growing crop. Therefore, a soil that is well aggregated and would ordinarily be expected to be quite permeable to water may be highly susceptible to surface runoff and erosion if the surface is unprotected.

This paper reports the results of 3 years of study to determine the effect of corn and soybeans produced with and without surface mulches on soil and surface water losses and on structure of the surface soil. A previous paper (7) reported the infiltration obtained from the various plots during the early part of the investigation.

PROCEDURE AND METHODS

In the spring of 1941, and again in 1942 and 1943, 24 plots, each 24.75 feet square, were planted in four series of six plots each. The following crops and treatments were located at random on the six plots in each series:

Plots 1—Soybeans, clean tilled, no residue.
Plots 2—Soybeans, subsurface tilled, 2 tons wheat straw.
Plots 3—Soybeans, clean tilled, residues, returned after harvest.
Plots 4—Corn, clean tilled, no residue.
Plots 5—Corn, subsurface tilled, 2 tons wheat straw.
Plots 6—Corn, clean tilled, stover returned after harvest.

On plots 2 and 5 the wheat straw was applied immediately after planting the respective crops. Subsurface tillage and control of weeds was practiced on these plots by the usual tools as the plots were too small to permit the use of large tools. On plots 3 the soybeans were cut for seed, the soybean straw was returned to the plots immediately after threshing. On plots 6 after the corn was harvested, the stalks were broken down on the contour. The entire crop was removed at harvest time from the plots numbered 1, 2, 4, and 5. After completion of artificial rainfall tests in April of each year, residues were removed from all plots by plowing and preparation of seedbeds for the following crop. Soybeans were planted in rows 20 inches apart and rows 40 inches apart.

Artificial rainfall was applied to the plots at the rate of 1.75 inches per hour with the type F rainfall simulator equipment used and its operation were described in a previous paper (7). Runoff was determined by weighing runoff in samples collected for intervals of 1 to 10 minutes depending on the rate of runoff. Soil losses were determined in 1941 and 1942 by drying samples of the runoff at frequent intervals. In 1943 the runoff was saved at the end of 1 hour, or in some instances at 2-hour intervals. Precipitate samples of the runoff were taken to determine soil samples for aggregate analysis were taken in May, 1943, before the land was plowed. The samples were taken with a spade to a depth of 5 inches from three locations in each plot and were composited. After becoming air-dry, the samples were put through a sieve with 1/8-inch openings. A aggregate analysis was made by a method very similar to that described by Peele and Beale (11).

The plots were located at Urbana, Ill., on a permeable prairie soil with a 4% slope. The soil is similar to a silt loam, but is leached of carbonates to a greater depth than is usual for Saybrook. A more complete description of the soil was given in a previous publication (7).

RESULTS AND DISCUSSION

RUNOFF

Effect of crop.—It is generally recognized that a crop of soybeans leaves the soil loose, and it is commonly assumed that the soil in this loosened condition is particularly susceptible to runoff and soil erosion. Browning, et al. (3) suggested three factors, one may logically assume to be primarily responsible for the looseness of the soil following a corn crop. Soybeans. However, the looseness of the soil following a soybean crop may result in increased infiltration and reduced runoff from soybean as compared with plots providing the surface of the soil is protected by a mulch or by the canopy furnished by a growing crop. Therefore, a soil that is well aggregated and would ordinarily be expected to be quite permeable to water may be highly susceptible to surface runoff and erosion if the surface is unprotected.

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