SOIL GRANULATION AND PERCOLATION RATE AS RELATED TO CROPS AND MANURING

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Reprinted from Journal of the American Society of Agronomy
Vol. 36, No. 8, August 1944

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THE resistance of a soil to erosion and to breakdown of its granulation may be considered a function of the stability of this structure.

A soil is commonly considered to be of less stable granulation and aggregation when it will break down readily under the influence of water. Such soil will flow together and puddle to become more or less impervious. The smaller granules may swell and interstices be filled by individual soil particles, thus sealing the soil to passage of both air and water. As a result, the runoff is increased, thereby increasing erosion. On the other hand, soils whose aggregates are stable enough to hold up under the action of rainfall permit its infiltration. Such soils are well aerated, have good drainage, and store water in significant amounts. Erosion is consequently reduced because of the reduction in runoff. The productivity of such soils is also higher.

There are many factors modifying the stability of granulation, the nature of the cementing materials, and the forces holding the particles together into the granular masses. It was the intent of this study to learn whether the stability of granulation was different in consequence of different crops and of the annual applications of barnyard manure.

PLAN AND PROCEDURE

The soils studied were taken from four plots of Sanborn Field at the Missouri Agricultural Experiment Station. One pair had been in wheat continuously and the other two plots in corn, all since 1888. One of each pair has had no manure treatment. The other has had 6 tons of manure applied annually. All the produce was removed from the plots. The plots are in close proximity and were handled alike so far as possible in all other respects.

Soil samples were taken as borings of the surface 7 inches, spread out indoors, and air dried. The samples were in approximately optimum moisture when taken and in a good state of granulation. The test of the stability of granulation consisted in a measure of the rate of infiltration and percolation of water through a constant volume of soil under a constant head of water.

For this test a volume of 160 cc of air-dry soil was tamped into a 2-inch brass cylinder with a tamping machine. The bottom of the cylinder was perforated and permitted collecting the percolate. Water was run into the cylinder above the soil and a constant depth maintained by means of over-flow. At regular time intervals of 3 minutes after introduction of the water, the amount of percolate was measured by taking 10 measurements, or for a total time of 30 minutes. Replicate measurements were made of the different samples and the duplications were so similar that the data are assembled as graphs in Fig. 1.

RESULTS

It is significant that the infiltration rate was much higher for the soil of both plots under the wheat crop than for the corresponding plots under corn, as shown by the percolation of the water through

[1]Contribution from the Department of Soils, Missouri Agricultural Experiment Station, Columbia, Mo. Journal Series No. 937. Received for publication February 19, 1944.

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the soil of the wheat plots in the short interval of 3 minutes. For the soil under the corn crop with manure there was no percolation until 6 minutes, and for that with no manure there was none until 18 minutes had passed.

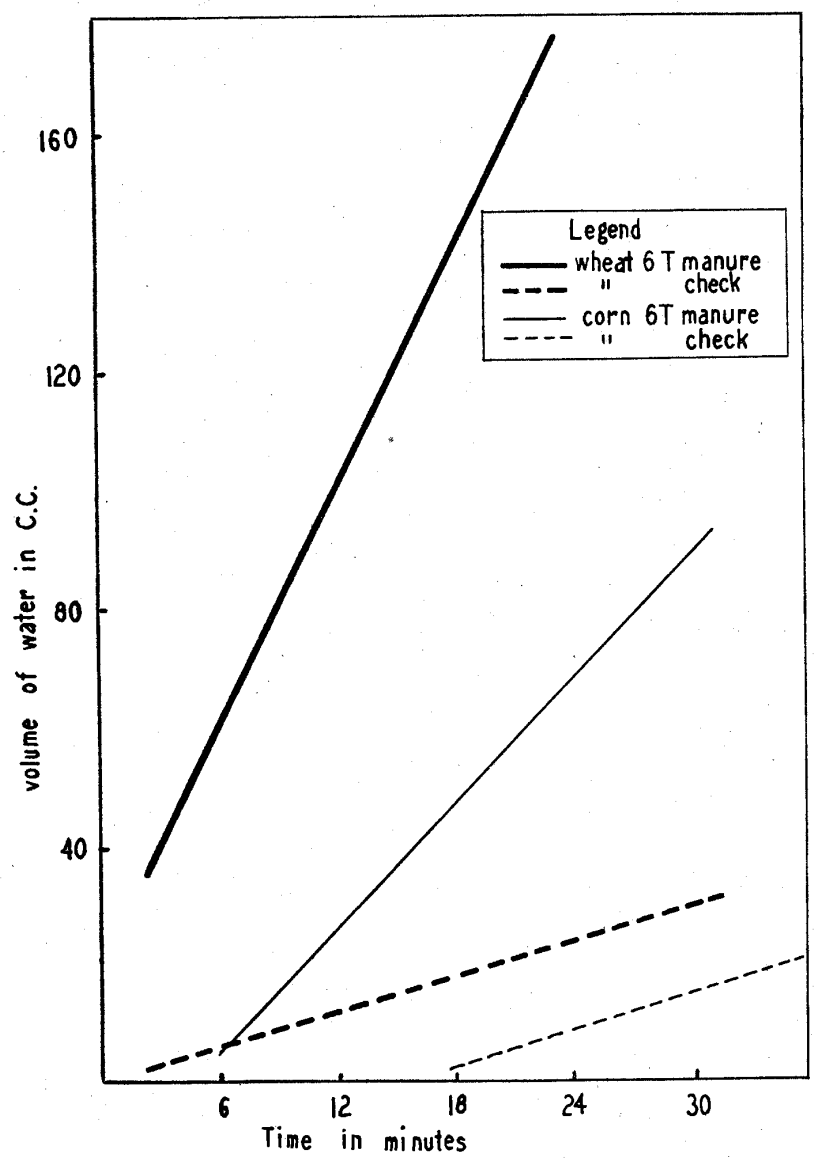

FIG. 1.—Time required for, and rate of, percolation through a soil under different crops with and without manure for 55 years.

The rate of percolation, regardless of the crop, was higher in consequence of the addition of manure. This beneficial effect of the manure was greater when coupled with the effects of the wheat than with those of the corn crop.

The time length under percolation study was not extended far enough to demonstrate much change in rate with increased time of percolation, except to provide a suggestion of a significant decrease in rate after 30 minutes for the soil without manure under wheat.

DISCUSSION

Why these two pairs of plots should be so widely different in stability of granulation of the soils is not readily explainable from their general appearances. These plots are managed differently only in the application of the manure on the surface for the wheat and plowing it under for the corn. There is also the extra surface cultivation for the corn crop.

The extra tillage might be taken as a factor in reducing the organic matter in the soil under corn through hastened decay by more aeration. Under wheat there are greater root additions and more intimate distribution of this organic matter in the immediate surface soil. Even though none of these soils is of a dark color, a visual examination would lead one to believe the manured soil under corn to be higher in organic matter than the manured soil under wheat.

The colors of the soil do not rank them in the order of their stability of granulation as measured by these tests, but their nitrogen contents do. In decreasing rates of infiltration, the plots arrange themselves in the following order: (a) Wheat, manured; (b) corn, manured; (c) wheat, unmanured; and (d) corn, unmanured. The decreasing nitrogen contents of the soils, and therefore their organic matter contents, arrange themselves in the same order according to the following figures as percentages: (a) 0.145, (b) 0.118, (c) 0.098, and (d) 0.071. This agreement emphasizes the fact that for these treatments the rate of infiltration of water into the soil varies with the organic matter content as measured by the nitrogen contents.

SUMMARY

Soils under continuous corn and wheat crops, both with and without manure for 55 years in Sanborn Field, were subjected to study of water infiltration and percolation in the laboratory. The results as reported point with particular emphasis to the effects by manure as organic matter. It encouraged a granulation that permitted increased infiltration. There was a greater stability of the granules as suggested by the nearly constant rate at which water percolated through a shallow soil layer for a limited time in contrast to its decreasing rate of percolation with time for the unmanured soils.

These results point to the less commonly recognized differences within the soils themselves that will modify their behavior in relation to rainfall and running water. They point particularly to the value of organic matter turned into the soil as it may be responsible for these differences, not readily recognizable by casual observation.