EFFECT OF CROP RESIDUES ON SOIL MICROPOPULATIONS, AGGREGATION, AND FERTILITY UNDER MARYLAND CONDITIONS

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The use of crop residues for the conservation of soil and moisture has raised many questions of practical importance as to the effect of the various residues and their methods of application on chemical, biological, and physical properties of the soils. Crop residues on the soil surface reduce runoff and erosion more than any other residue management practice (4, 5). The effects of mulching, disking, and plowing of wheat straw and legume residues on the microbial populations, aggregation, nitrate nitrogen content, and wheat yields of a soil used for growing a 1-year rotation of winter wheat followed by lespedeza are discussed in this paper.

There is considerable literature concerning the action of microorganisms on the formation of water-stable aggregates. One of the early investigations along this line was conducted by the Russian workers, Kanivetz and Korneeva (7). They showed that an improvement in soil structure was obtained by adding pure and mixed cultures of bacteria and fungi and sugar beet residues to the soil.

Myers and McCalla (15) reported highly significant relationships between soil aggregation and numbers of bacteria present over an extended period of incubation. Since aggregation was found to lag behind peak populations, the conclusion was reached that the improved state of aggregation was a result of the binding effect of the products of microbial metabolism.

Martin (9) found that the effect of organic materials in promoting soil aggregation was related to their content of readily decomposable substances. Later work by Martin (10) showed that two specific soil microbes, a fungus belonging to the genus Cladosporium and bacteria belonging to the Bacillus subtilis-mesentericus group, were instrumental in promoting soil aggregation. Metabolic products were shown to be responsible for a considerable portion of the aggregating effect. However, the binding effect of the mycelium played an important role where the fungus was concerned.

Peele (16), Peele and Beale (17, 18), and Martin and Waksman (11, 12) have also presented evidence of relationships between the microbial populations of a soil and the formation of water-stable aggregates.

McHenry and Russell (14) have shown a relationship between microbial activity as determined by the rate of carbon dioxide evolution and aggregation of soil materials in the laboratory.

Martin and Anderson (13), working with fungi involved in the decomposition of organic substances in the soil, have pointed out a relationship between the chronological sequence of certain fungi and the ability of these organisms to form aggregates.

EXPERIMENTAL

Twelve plots, as shown in Fig. 1, were used. After harvesting the lespedeza in October, all plots were given a 1-year treatment of 2-12-6 fertilizer. Wheat straw residue was returned to six of the plots, while the residue was returned to the remaining six. These treatments were applied at the rate of 1½ tons per acre in 1943, the amounts used approaching those normally produced in the field. Each of the remaining treatments applied (a) as a surface mulch, (b) by disking, and (c) by plowing. All treatments were applied to the plots according to a randomized procedure.

Soil samples were taken at two depths, 0 to 3 inches, on June 1, August 31, and October 10. Other samplings made on June 1 were in a friable condition, those made on October 10 were high in moisture content of preceding rainfall, while those of August 31 were dry. Fig. 2 shows graphically the rainfall and soil moisture picture during the entire sampling season. Total counts of bacteria and actinomyces were determined by the dilution plating method using soil extract agar, while oxidase counts were made on glucose-nitrate-soil extract agar, on which rose bengal had been added in a concentration of 1:15,000, as recommended by Smith and Dawson (19). Quadruplicate plates were made for each sample. Total counts include both bacteria and actinomyces and are expressed as millions per gram of soil. Fungi are expressed as thousands per gram of soil. The number of oxidase-positive fungi was determined by the use of tannic acid agar (1, 2). Nitrates were determined by Harper's modification (6) of the phenoldisulfonic acid method.

The soil samples taken on October 10, 1944, after the plots had been in operation, were subjected to aggregate analysis. Samples from the two depths were combined so that the results obtained on aggregate analysis.