Soil Aggregation as Influenced by the Growth of Mold Species, Kind of Soil, and Organic Matter

C. M. GILMOUR, O. N. ALLEN, and E. TRUOG

Various investigators have emphasized the role of microorganisms in the aggregation of soil particles (4, 5, 8, 13). Among the factors influencing this phenomenon are organic residues, temperature, and moisture content of the soil (7). In general, the effectiveness of molds in aggregation has been shown to be related to their chronological appearance during the decomposition of organic materials in soil (9, 10). The structural condition of soils is also known to be influenced by the relative proportions of fine and coarse particles (3). It may be expected that soil texture in conjunction with the decomposition of organic matter would affect the degree of aggregation brought about by molds. In consequence, the purpose of this study was to investigate the influence of particle size and distribution and type of organic matter on the formation of aggregates by certain mold species.

MATERIALS AND METHODS

Types of Soil and Treatment

Samples from the A horizons of three cultivated Wisconsin soils, Plainfield sand, Spencer silt loam, and Superior red clay, were used in this investigation. Plainfield sand typifies a soil of extremely sandy nature and contains a low percentage of silt and clay. Spencer silt loam is characterized by a high silt content, a moderate clay fraction, and a loose, friable texture; in contrast, Superior red clay has a high silt and clay content, typical of a true clay soil. A mechanical analysis of these soils by the International Pipette procedure (14) is given in Table 1.

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Coarse sand %</th>
<th>Fine sand %</th>
<th>Silt %</th>
<th>Clay %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plainfield sand</td>
<td>87.30</td>
<td>1.12</td>
<td>0.84</td>
<td>10.74</td>
</tr>
<tr>
<td>Spencer silt loam</td>
<td>8.08</td>
<td>35.94</td>
<td>34.98</td>
<td>21.00</td>
</tr>
<tr>
<td>Superior red clay</td>
<td>3.12</td>
<td>10.70</td>
<td>42.21</td>
<td>44.96</td>
</tr>
</tbody>
</table>

Prior to treatment each soil was passed through a 2 mm screen after which 150-gram portions of the finer material were placed in glass tumblers. One-third of the samples of each soil type received 1% (the equivalent of 10 tons per acre) of freshly ground alfalfa meal; another third, ground oat straw; and the remaining one-third received no organic treatment. The soils were then brought to a favorable nutrient status and moisture level (sand 16%, silt loam 30%, and clay 35%) by the addition of suitable amounts of the following solution:

\[
\begin{align*}
\text{K}_2\text{HPO}_4 & \quad \text{——————————} \quad 0.50 \text{~gram} \\
\text{FeCl}_3 \cdot 5\text{H}_2\text{O} & \quad \text{——————————} \quad 0.01 \text{~gram} \\
\text{MgSO}_4 \cdot 7\text{H}_2\text{O} & \quad \text{——————————} \quad 1.0 \text{~gram} \\
\text{NaCl} & \quad \text{——————————} \quad \frac{1}{1000} \text{~gram} \\
\text{H}_2\text{O (distilled)} & \quad \text{——————————} \quad 999.50 \text{~gram}
\end{align*}
\]

Each tumbler was then covered with a petri dish and autoclaved at 15 pounds pressure for 12 hours. Prior to inoculation, the soil in each tumbler was shown to be sterile by plating aliquot samples on nutrient agar. The soils to which oat straw and ground alfalfa meal were added were referred to as “treated”; those receiving no addition of organic matter are designated as “non-treated”.

Nine mold species common to soil were used as test organisms. With the exception of the non-inoculated soil type, duplicate tumblers of each soil were treated with 1 ml spore suspensions of the respective organisms. The soil samples were analyzed after an incubation period of 30 days at 28°C. Sterile distilled water was added when necessary to maintain the desired moisture level. Periodic checks were made for the detection of contaminants.

Aggregate Analysis

After the incubation of all samples, including uninoculated controls, the soils were allowed to air dry, and duplicate samples of 400 grams each of Plainfield sand and 20 grams each of Spencer silt loam and Superior red clay were analyzed for amounts of unbound silt and clay in suspension. The procedure for aggregate analysis consisted of sampling by means of a calibrated pipette, followed by the use of a photo-electric turbidimeter to that outlined by Jackson (2). The weighed placed in a liter graduate and water added to make the mark. The graduate was then inverted end over end, and, after a settling time of 125 seconds, a 25 ml aliquot from the suspension at a depth of 20 cm. The suspension was then transferred directly to a 7 × 3 cm Evelyn colorimeter tube and the tube inverted to complete dispersion. At the onset of the turbidities, the galvonometer was adjusted to a reading of 100 (water). A 660 μ red filter was used. Thereafter, the various silt and clay suspensions were assayed as 2-log G.

The amounts of unbound silt and clay in the suspensions were determined by referring the turbidity of the suspensions to the standard curve obtained with the respective non-treated soil. These line functions were then used to determine the amounts of sedimentary material in the suspensions showing readings below 10 were not necessary, so as to fall within the desired range of the curve. In these latter instances the amount of sedimentary material in suspensions was reckoned by weighing the residue following evaporation.