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Size Distribution of Soil Aggregates as Influenced by Microorganisms

H. E. Weakly
University of Nebraska-Lincoln

T. M. McCalla
University of Nebraska-Lincoln

Francis A. Haskins
University of Nebraska-Lincoln, fhaskins@neb.rr.com

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NOTE

Size Distribution of Soil Aggregates as Influenced by Microorganisms.[1] Numerous reports (for example 2–7) have presented evidence that soil aggregates are formed and/or stabilized by microorganisms. In most instances, the aggregates were not studied in respect to size distribution. The present report is concerned with the size distribution of aggregates and particles in a soil material after inoculation with three different inocula and incubation for varying periods of time.

Peorian loess subsoil, a material virtually devoid of water-stable aggregates, was used. Prior to use, the Peorian loess was passed through a 2-mm. sieve.

Fifty-four petri plates, each containing the equivalent of 35 g. of oven-dry soil, were prepared. These plates of soil were autoclaved for 1½ hours, after which 0.35 g. of autoclaved, ground wheat straw was added to each. The plates and contents were then autoclaved for an additional 1½ hours.

Stachybotrys atra (2), a formaldehyde-resistant *Fusarium*, and a suspension of topsoil were used as inocula. All inocula were prepared in a sterile solution containing the following salts in 1 liter of water: NH_4NO_3, 8 g; K_2HPO_4, 4 g; $MgSO_4 \cdot 7\ H_2O$, 2 g; and $FeSO_4$, less than 0.1 g. At the time of inoculation, each plate received the equivalent of 3.5 ml. of this salt solution and sufficient water to bring the moisture level to approximately field capacity. Eighteen plates of each soil were inoculated with each of the three inocula. Inoculated plates were weighed and then incubated at 25° C. At weekly intervals each plate was brought to its original weight by the addition of sterile water.

At the end of 1, 2, 4, 8, 12, and 16 weeks, three plates representing each of the three inocula were removed from the incubator and air-dried. Prior to drying, a small sample of soil from each aggregation plate was plated on soil extract and rose bengal agars for qualitative examination of the microflora present.

After all plates had been dried, determinations of size distribution were made for each. Wet-sieving was used to separate water-stable aggregates and particles larger than 50 μ by Yoder's method (9) as modified by Swanson *et al.* (8). Ultimate particle-size analysis was used for particles of less than 50 μ by the standard procedure of Bouyoucos (1).

As shown in figure 1, the aggregation of Peorian loess was modified considerably. The Peorian loess in the field contains 14 per cent sand (>50 μ), 66 per cent silt (2 to 50 μ), and 20 per cent clay (<2 μ) with virtually no natural aggregation.

The uninoculated control, autoclaved and with nutrient solution, resembled the 0-time sample for all treatments until it became contaminated after 2 weeks of incubation, as indicated by plate counts of fungi and bacteria. It then resembled the plates inoculated with soil flora.

Plating of each treatment at each interval of incubation showed the *S. atra* and *Fusarium* sp. present in their respective treatments in apparently pure culture. The plates inoculated with soil showed a variety of bacteria and fungi present.

After inoculation and incubation of the Peorian loess, there was a significant shift, as determined by analysis of variance and Duncan's Multiple Range test, in the size distribution of aggregates in the direction of larger sizes. With time there was a significant change with the three inocula in all size classes. Within one week all the clay-size particles (all three inocula) became aggregated into units greater than clay size, and none of the clay-size particles (<2 μ) reappeared even after 16 weeks of incubation. Likewise, with only two exceptions, none of the small silt-size fractions (2 to 5 μ) reappeared.

Within one week after inoculation with the soil flora, there was a significant increase in the per cent of the soil material present as sand-size aggregates (50 to 1000 μ). Even after 16 weeks of incubation, this general increase was still evident, although the coarse sand-sizes

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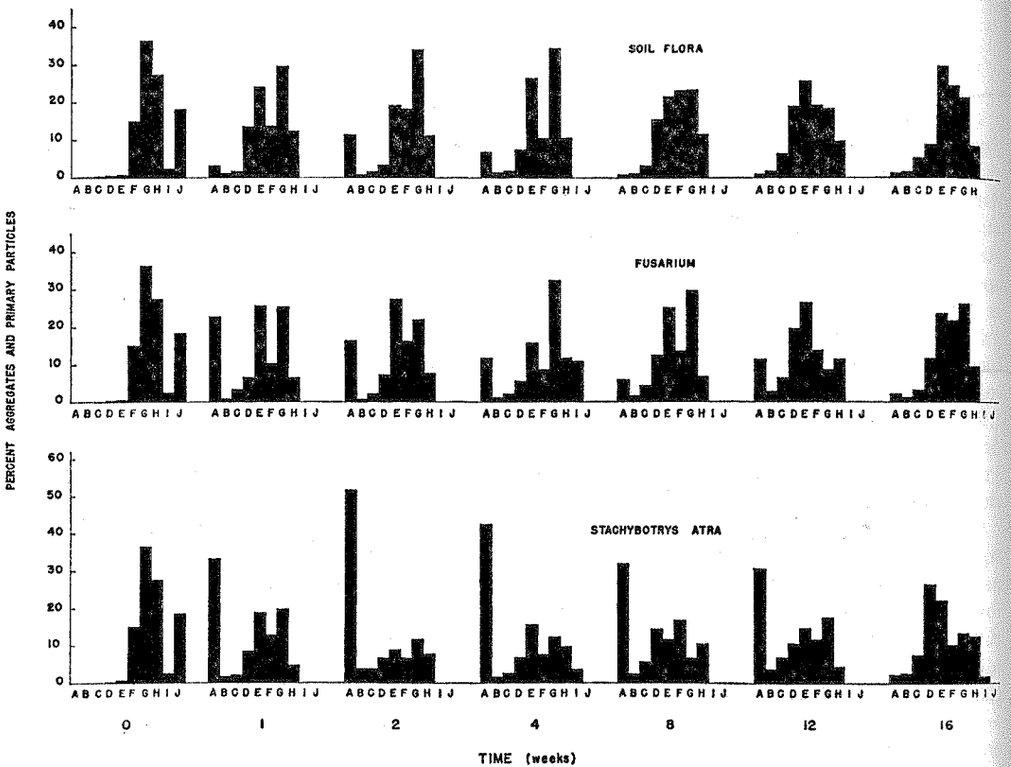

FIG. 1. Effect of duration of incubation upon the size distribution of soil aggregates and particles in Peorian loess inoculated with various microorganisms: $A = > 2000\mu$; $B = 2000\text{-}1000\mu$; $C = 1000\text{-}500\mu$; $D = 500\text{-}250\mu$; $E = 250\text{-}100\mu$; $F = 100\text{-}50\mu$; $G = 50\text{-}20\mu$; $H = 20\text{-}5\mu$; $I = 5\text{-}2\mu$; and $J = < 2\mu$.

were diminished after 4 weeks. Inoculation of the soil material with the *Fusarium* microorganism also caused a significant shift in the per cent aggregates toward the sand-size range. This shift persisted throughout the 16-week incubation period. There was a significant increase in aggregates in the size greater than 2000 μ, which reached its maximum after 1 or 2 weeks incubation. A similar pattern existed for the Peorian loess inoculated with *S. atra*. The most striking effects, however, were produced by *S. atra* in aggregates greater than 2000 μ. About 52 per cent of the total soil material at the 2-week incubation interval was made up of aggregates of this size range. The data indicate that these aggregates were quite stable for at least 12 weeks, but between the 12th and 16th weeks of incubation they were degraded extensively.

It is evident that the activity of soil microorganisms causes appreciable shifts in the amounts of soil found in the various size fractions. In the aggregate size range of greater than 2000 μ, the stability was temporary, persisting for 8 to 12 weeks for *Fusarium* and *S. atra*. In the smaller-sized classes, the stability was more permanent, existing beyond the 16-week incubation period. Visual examination of the plates showed that considerable amounts of fungal mycelia were present following inoculation with the *S. atra* or *Fusarium* sp. This mycelial growth may have contributed to the observed aggregation.

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H. E. WEAKLY, T. M. MCCALLA, AND F. A. HASKINS
University of Nebraska, Lincoln

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