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Thesis Summary

A Study of Some Physical and Chemical Factors of Soil Aggregation in Some Soils of Peninsular Malaysia

Acid soils representing twelve common soil series of Peninsular Malaysia, varied widely in parent material, chemical properties and mineralogical composition of their clay fractions.

The three basic techniques used to study aggregate formation in soils of Peninsular Malaysia were: analytical technique in which physical and chemical data of total soil were correlated with selected parameters of soil aggregation; extraction technique in which changes in soil aggregation were determined following extraction of the aggregates with different solvents; and, addition technique in which selected aggregating agents were added to clay-sand mixtures and their direct effects on soil aggregation were determined.

Both percentage aggregation (0.25%) and mean weight diameter were found to be significantly different among the twelve soils, at each soil horizon investigated. Aggregation between soil horizons in each soil series was also found to be significantly different, with the topsoil having higher percentage aggregation (0.25%) and larger mean weight diameter than the subsoil. These structural differences among soils and among horizons within a soil were found to be influenced by mechanical composition, clay mineralogy, organic substances and sesquioxides.

Simple and multiple regression analyses showed that the content of clay had no significant relationship with either percentage aggregation (0.25%) or mean weight diameter. However, both parameters had significant positive relationships with the cation-exchange capacity of the clay fraction, indicating that 2:1 lattice clay minerals have better aggregating effect than 1:1 lattice clay. In simple regression analysis, the content of silt correlated significantly with percentage aggregation (0.25%) and mean weight diameter though its importance was not shown in multiple regression analysis. The results suggest that silt may also play a role in the aggregation of soils in Peninsular Malaysia.

Decomposed organic matter had pronounced influence on percentage aggregation (0.25%) and mean weight diameter, while the undecomposed forms, such as, particulate matter had little influence. Aggregate analysis carried out after complete oxidation of the organic matter in the test soils with H_2O_2 showed that almost all the waterstable aggregates larger than 0.25 mm were broken down into micro-aggregates and/or primary soil particles. Statistical analyses also substantiated the importance of decomposed organic matter in the aggregation of Peninsular Malaysian soils. Both organic carbon and total nitrogen contents had significant positive relationships with percentage aggregation (0.25%) and mean weight diameter.

The influence of four types of organic substances, *viz.*, particulate matter, soil polysaccharides, humic acid and fulvic acid, was also studied. The content of particulate matter in the soils was too low to be of any value as an aggregating agent. Statistical analyses showed that it had no significant relationship with either percentage aggregation (0.25%) or mean weight diameter. In the case of soil polysaccharides, both statistical analysis

and sodium periodate treatment showed that they had little influence on aggregation. Humic and fulvic acids had significant positive correlations with percentage aggregation (0.25%) and mean weight diameter. When small amounts (<2.0% weight/weight) of purified humic and fulvic acids were added to clay-sand mixtures, rapid aggregation of the clay particles took place.

The effect of sesquioxides on aggregation of the twelve soils was not clearly defined by statistical analysis and the extraction technique. Simple regression analysis showed that both total and dithionite extractable iron oxides were significantly correlated with percentage aggregation (0.25%), but not with mean weight diameter. Total and dithionite extractable aluminium oxides had no significant relationship with the two parameters. A combination of total and dithionite extractable iron oxides, total and dithionite extractable aluminium oxides accounted for 22% and 6% of the variations in percentage aggregation (0.25%) and mean weight diameter, respectively. The changes in aggregation of the soils after extraction of iron and aluminium oxides and hydroxides with sodium dithionite followed no consistent trend. In some soils, sodium dithionite treatment led to a reduction in percentage aggregation (0.25%) and mean weight diameter, but the magnitude of the reduction was found to be small in most cases. In others, it caused a slight increase in both parameters.

The aggregating effects of iron and aluminium oxides on clay were distinctly shown by the addition technique in which hydrated iron and aluminium oxides gels were added to kaolinitic clay-sand mixtures. Even at low concentrations (4% weight/weight), both iron and aluminium oxides promoted a high degree of aggregation on the clay particles. The process of wetting and drying enhanced the aggregating effect of iron oxides, but destroyed that of aluminium oxides.

Under acid conditions, both humic and fulvic acids interacted significantly with hydrated iron and aluminium oxides in cementing and stabilising kaolinitic clay into stable aggregates. These interactions suggest that formation of humus-sesquioxides complexes could be the most important aggregating agent in soils of Peninsular Malaysia.

The knowledge that organic matter has pronounced effect on soil aggregation provides the basis for preserving or enhancing the structure of agricultural soils by implementing appropriate management practices, such as cropping systems and cover management, that will increase further the organic matter status of these soils. However, for immediate improvement of soil structure, soil conditioners can be used with equal effectiveness.

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