Soil Organic Matter

The nature, content and behaviour of the organic matter, or humus, in soil are factors of fundamental importance for soil productivity and the development of optimum conditions for growth of crops under diverse temperate, tropical and arid climatic conditions.

In the recent symposium on soil organic matter studies – as in the two preceeding ones in 1963 and 1969 – due consideration was given to studies involving the use of radioactive and stable isotopes. However, the latest symposium was a departure from previous efforts in that non-isotopic approaches to research on soil organic matter were included.

A number of papers dealt with the behaviour and functions of organic matter and suggested improved management practices, the use of which would contribute to increasing agricultural production. Other papers discussed the turnover of plant residues, the release of plant nutrients through the biodegradation of organic compounds, the nitrogen economy and the dynamics of transformation of organic forms of nitrogen. In addition, consideration was given to studies on the biochemical transformation of organic matter, characterization of humic acids, carbon-14 dating and the development of modern techniques and their impact on soil organic matter research.

A paper giving a historical review showed that the very favourable effects of organic matter on soil fertility were recognized already by the first human civilization which began with the settlement of nomads to establish organized agricultural activities. The important role the organic matter plays in enhancing biological activities and improving the soils' physical and chemical properties were also reviewed.

A report was presented on recent findings on the characterization of humic substances extracted from soils from widely differing climatic zones. All humic materials were extracted, fractionated, purified and analyzed by the same method. The analytical, spectrophotometric and spectrometric data and the information provided by chemical degradation showed that humic substances formed under widely differing climatic conditions had essentially similar chemical structures and characteristics. Major humic "building blocks" were in all instances complex phenolic and benzenecarboxylic structures. Most of the aliphatics were n-fatty acids which appeared to be esterified to phenolic OH groups. Recent physio-chemical studies showed that humic and fulvic acids behave like linear, flexible polyelectrolytes that are readily aggregated, most likely with the aid of H-bonding, at low pH but dispersed, due to increased dissociation of functional groups, at higher pH. Thus, it becomes apparent at this time that humic and fulvic acids are not single molecules but molecular associations of phenolic and benzenecarboxylic compounds ("building blocks") of microbiological, polyphenolic, lignin and condensed lignin origins. The "building blocks" appear to be held together by weak linkages, mainly H-bonds.

Root formation and decomposition during plant growth were discussed in another paper. The results of research on mustard and wheat plants with the aid of carbon-14 indicated

that the remaining root carbon at harvesting time represented only one fourth of the total root material formed during the growth season. Hence, the role of plant roots in soil organic matter turnover and maintenance can not only be evaluated on the basis of their residual quantity at harvest time but is of much greater importance both as a source of soil humus and of microbial energy. Plants may require one third of their assimilatory power in order to synthesize their root system and to maintain its functions.

Comparisons of pairs of soils from seven soil series of similar soil type were made. One of the pairs was from long-term pasture and the other from an adjacent continuously cultivated site. The pasture soils had consistently higher values for C, N and S than their arable counterparts but the mean C:N ratios were similar for both sets of soils. However, the mean C:S ratio was significantly lower in the arable soils than in the pasture soils indicating that sulphur is more stable than carbon and nitrogen, and tends to resist mineralization in the field situation. This was confirmed through measuring the amounts of mineralized nitrogen and sulphur in incubated soils in laboratory studies.

Another paper reported a field experiment designed to determine the extent to which digested municipal sludge (5% dry matter) could be applied to serve as a source of plant nutrients and the limits posed on its use by the presence of toxic elements and compounds. The results showed that amounts up to 3000 m^3/ha did not reduce crop yield. The residual effect even of low rates (140 m^3/ha) is still visible in the fifth year after application. In addition, the investigations indicated that rates of 100 to 200 m^3/ha/year did not appreciably influence the soil water at 1 m or deeper. Heavier application rates led to an increase in nitrate contents of the soil water and to some extent of Ca, Mg, Cl, K as well as Zn and Cd. Based on the results obtained, it was proposed that the amount of sludge to be annually applied to agricultural land should depend on its nitrogen content, take into consideration the nutrients requirements of plants, and may reach the limit of 200 m^3 digested sludge/ha/year, which is equivalent to about 200–400 kg N/ha. A formula for determining the total sludge load from the metallic contents has also been suggested.

A study on the bacterial biodegradation of polysaccharides absorbed on clay minerals (montmorillonite) stimulated great interest in organo-mineral complexes and indicated the need for further investigations in this field. The discussions also showed the need for further research to understand the reasons for the great stabilitiy and extraordinary resistance of fulvic and humic acids for degradation in soils. Furthermore, various papers stressed the importance of slow-release nitrogenous fertilizers and indicated the need for more field investigations with the aid of nitrogen-15 labelled compounds.