USE OF ISOTOPES AND RADIATION IN SOIL ORGANIC-MATTER STUDIES

REPORT ON THE AGENCY SYMPOSIUM HELD IN VIENNA, AUSTRIA, FROM 15 TO 19 JULY 1968

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. Unfortunately, the study of soil organic matter presents some of the most complex problems with which the soil specialist and his collaborators in soil biochemistry and soil microbiology have to deal. However, tracer techniques involving the use of radioactive and stable isotopes have resulted in substantial advances in knowledge of the behaviour and functions of organic matter in soil.

As part of their cooperative contributions to the international programme for promoting the peaceful uses of atomic energy, and to the Freedom from Hunger Campaign, which has as its aim the mobilization of all resources to free the world from hunger and malnutrition, the Food and Agriculture Organization of the United Nations and the International Atomic Energy Agency had jointly convened in 1963 an international meeting to review the progress that had been achieved through the use of tracer techniques in studies of soil organic matter and the ways in which it could contribute to the growth of better crops. The proceedings of that meeting were published by Pergamon Press early in 1966. Owing to the wide interest in this subject and the many research developments which have occurred since 1963, the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations, in cooperation with the International Soil Science Society, sponsored this second symposium. Its basic purpose was to promote the exchange and publication of information which could lead to improved food supplies and better nutrition for all peoples. Experts from 17 countries presented 48 scientific papers each of which was followed by a discussion; in all, 100 scientists from 33 Member States attended.

The symposium consisted of nine sessions devoted to the presentation of scientific papers and to discussions on the following six topics:

1. Laboratory techniques for studying soil organic matter.
2. Properties of soil organic compounds.
4. Organic matter synthesis and decomposition in soils (2 sessions).
5. Organic matter in tropical soils.
6. Organic-matter effects on nutrient availability in soils (3 sessions).

All the papers and discussions emphasized the value of using isotopically labelled organic-materials in studies of organic-matter transformations and organic-matter effects in soils. Organic substances labelled with $^{14}$C and $^{15}$N have provided a method of separating fresh, decomposable organic matter added to the soil from the older, more stable humus material in the soil.
The research studies indicate that a relatively stable situation develops following the first few weeks of vigorous microbial activity after an addition of organic matter to the soil. After this initial period the rate of net mineralization decreases to a low level and the distribution of the remaining organic C among the different analytical fractions does not change appreciably. Additions of fertilizer N as NH₄ are rapidly incorporated into the soil organic matter through ammonia fixation or biological assimilation and the added N is soon present in all fractions of the soil organic matter obtained by chemical extraction procedures. Additions of N as NO₃ remained in the NO₃ form unless energy material with a low N content was also added to the soil.

Results of research were reported on the problems encountered in the separation and analysis of different organic compounds which occur as complex mixtures in the complex organic-inorganic soil system. Various techniques are being developed to help solve these problems. A technique for combustion and for radioassay of isotopes such as ³H, ¹⁴C and ³²P in plastic bags was presented. The use of gel filtration and its value, when used together with isotopic labelling of different fractions of the organic matter, for separating homogeneous fulvic acid fractions was discussed. Results of studies using ¹⁴C-labelled organic compounds to study the stability of different humus compounds and their rates of mineralization and interconversion were presented. The results indicated that the formation and accumulation of humic substances in soils does not follow a reaction pathway through various intermediate fractions, but that both mineralization and interconversion occur with both the old and the recently added organic materials. Results were reported of laboratory experiments using ¹⁴C-labelled proteins, glucose, phenols, and various aliphatic precursors to study the formation of humic substances in soils. Other papers were presented reporting the results of field, greenhouse, and laboratory experiments using additions of ¹⁴C-labelled plant materials and animal manures. In all the experiments the added isotopically-labelled organic materials were soon incorporated into all of the different organic fractions in the soils. Loss of carbon through evolution of CO₂ from the decomposing organic materials was rapid soon after an organic-matter addition to the soil, with only 20 to 30% of the added C remaining in the soil after a few months. Additions of animal manures on decomposed dung left no more stable organic residues in the soil than did additions of corresponding amounts of plant materials. The CO₂ released from decomposing organic materials in the soil supplied only negligible amounts of the C used in photosynthesis by plants growing on the soils. In contrast to some popular concepts, additions of manures significantly increased the organic-matter content of some tropical soils. Studies using ¹⁴C-labelled triazine herbicides showed that different plant materials decomposed in soils to produce humic substances which were similar with respect to triazine adsorption and that the fulvic acids in the humus could be important in the inactivation through hydrolysis of the triazine herbicides. Reports were given of experimental results obtained using ¹³¹I, ¹³⁴Cs, ¹³⁷Cs, ⁶⁰Co, ⁸⁵Sr and ¹⁴⁴Ce to study the effects of chelation by soil organic matter and the microbial immobilization and cycling of these fission products on the losses and migration of these nuclides in soils.

The effects of organic matter on nutrient availability to crop plants being grown on soils was considered in reports of research in which ³²P,
Zn, Mn, Fe, C, Ca, Sr, Br, Rb and Cs were used to study the effects of such factors as: (1) the rhizosphere around plant roots; (2) Fe deficiencies in plants as they influence root excretions from the plants; (3) chelation and other interactions between nutrient elements and the organic matter in soils; (4) organic matter as it influences the formation and aging of calcium phosphates and the loss of P availability in soils; (5) the availability of phytin P to plants; and (6) the uptake and utilization of phenolic compounds by plants.

The session on tropical soils emphasized the special problems of these soils, which are different from those of soils in temperate regions where most research has been conducted. Research information on tropical soils is very limited. Results of experiments using $^{15}$N to study non-symbiotic N fixation and $^{32}$P to study P fixation in tropical soils were reported. However, it was obvious that much more research to provide "a causal analysis of the dynamic systems" found in tropical soils is needed, and that the use of isotopes - especially the isotopes of N, P, S and C - would be extremely valuable in this research.

The complete proceedings of the symposium will be published shortly by the International Atomic Energy Agency.

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Physical chemistry of the positron and positronium, by V.I. Goldanskii

page 137, 14 lines from bottom
For Ref. [286] read [285]

page 148, last line of list of references
For Ref. [286] read [106a]