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THE USE OF ^{14}C IN STUDIES OF MICROBIAL ACTIVITIES IN SOIL AGGREGATES

A Thesis

submitted by

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SUMMARY

The following topics were surveyed in the literature review:

(a) studies of soil organic materials using ^{14}C,

(b) methods of determination of ^{14}C,

(c) influence of aggregates on microbial activities,

(d) drying and wetting cycles in soils.

A method was developed to determine ^{14}C in finely ground soil samples, stabilized by CAB-O-SIL as suspensions, in toluene-PPO-dimethyl POPOP scintillant. Addition of internal standards to samples yielded efficiencies which allowed 100% recoveries of activity provided (a) samples were ground to <53 μm diameter and (b) weights of samples were such that the optical density of the gel remained below 0.9 at 450 nm in a 1 cm cell.

The method was applied successfully to counting of ^{14}C in soils, plant materials and freeze-dried, coloured extracts of soils.

Incubation of ^{14}C-labelled glucose and starch incorporated into soil from which aggregates were prepared show that several factors are involved in the metabolism of organic substrates in soil aggregates. Two peaks of $^{14}CO_2$ release occurred, the first between the 2nd and 5th days of incubation, and the second on the 8th or 9th days of incubation. In a fine sandy loam the first peak was shown to be due to a dominantly fungal population which utilized all ^{14}C-glucose releasing about 40% of the ^{14}C present as $^{14}CO_2$. In clay soils studies with single organisms suggested that bacteria were dominant during incubations of ^{14}C-labelled carbohydrates in aggregates.

With the odd exception, all soils amended with either ^{14}C-glucose or starch showed greater release of $^{14}CO_2$ from control samples (substrates present in macropores only) than from aggregate samples (substrates in micropores and macropores). The rate of release of $^{14}CO_2$ during incubation of ^{14}C-glucose was inversely related to the size of aggregates in a fine sandy loam. For samples amended with starch release of $^{14}CO_2$ was slightly higher from the larger aggregates.

A self-mulching clay showed the opposite trend with the release of $^{14}CO_2$ during incubation of ^{14}C-glucose being proportional to the size of aggregates. When starch was the substrate the rate of release of $^{14}CO_2$ was again higher from the larger aggregates.

Physical disturbance by either drying and wetting cycles or mechanical disturbance of aggregate samples pre-incubated with a ^{14}C-labelled substrate caused a flush of microbial activity based on $^{14}CO_2$ evolution. The results showed that physical factors should be considered together with biological and chemical factors in interpretation of the flush of activity caused by a drying and wetting cycle.

In a fine sandy loam fungi were more active than bacteria when substrates were present in micropores and macropores of soil aggregates but both groups of organisms were active when substrates were within macropores only (controls). On the other hand, in a clay both groups of organisms competed well throughout the incubations probably due to the pore size distribution and more favourable pH for bacteria.