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Pattern of Humus Decomposition in East African Soils

Humus decomposition under bare fallow has now been measured during five successive wet and dry seasons. Soil samples were taken periodically (about once a week during the wet season) and put in the macro-respirometer[1]. The average daily rate of decomposition for the following two days was taken as a comparative measure of the rate at the time of sampling. Using this technique it was found that a relatively high and similar rate of decomposition occurred at the start of each wet period but fell rapidly as uniform moist conditions continued (for example, from 12 mgm. carbon per day at the start of the rains to 4 mgm. three to four weeks later with a soil containing about 6 per cent carbon). Decomposition during the intermediate dry periods was almost negligible.

This simple pattern of composition is of fundamental importance. Since decomposition involves nitrate production it puts soil nitrogen availability on a more predictable basis and emphasizes the importance of timing in planting. This should be done before the start of the rains, or as soon after as possible, when nitrate production is at a maximum, rather than later, when production is much slower and losses of nitrate produced earlier may have occurred through leaching. The pattern also shows that humus decomposition proceeds spasmodically according to the drying and wetting cycle and involves, on each occasion, the rapid decomposition of discrete amounts of humus rather than the slow decomposition of the humus fraction as a whole (see below). An appreciation of this behaviour, and the slow rate of decomposition which may be reached under steady moist conditions, should be of value in work involving humus depletion and build-up. The persistence of this behaviour has been demonstrated in laboratory experiments with the same soil. After forty successive oven-drying and rewettings, with decomposition after each rewetting, the flush of decomposition still occurs, but is declining in magnitude as the reserve of decomposable organic material gets less. So far about 35 per cent of the total soil carbon has been decomposed in this way.

Recent work has shown that while an air-dry soil saturated with different bases gave very different amounts of soluble organic material (10 gm. soil extracted with 40 ml. water), the magnitudes of decomposition (100 gm. soil at field capacity) were almost identical. Similar results, but of greater magnitude, were obtained with the oven-dry soils.

	Air-dry			Oven-dry		
	Na	K	Mg	Na	K	Mg
mgm. organic nitrogen/10 ml. extract	0·44	0·26	0·12	0·43	0·40	0·20
mgm. carbon decomposed in 16 days	77·7	77·7	76·4	113·9	120·6	123·3
*p*H	6·3	6·6	7·1	6·3	6·8	6·9

Evidently decomposition involves the humus itself, is little affected by the base present and is not dependent on the preliminary solution of organic material. It appears from this, and further evidence to be published elsewhere, that the drying effect is due almost entirely to its influence on the microbial population. In this respect the uniform pattern of decomposition following each successive drying and rewetting is noteworthy. Since there is ample available substrate, as shown by the frequency with which the drying effect occurs, the rapid fall-off in the rate of decomposition after each rewetting may be due to the development of unfavourable conditions. Alternatively, the same bacterial culture cycle may follow each re-wetting, with high metabolic and enzyme activity during the early phase (characterized by high uptake of oxygen, evolution of carbon dioxide and production of ammonia) falling off during the stationary phase and period of decline. Heat activation of spores may also be involved, and these possibilities are being investigated.

This repetitive behaviour of humus decomposition emphasizes the importance of the wetting and drying cycle in soil fertility. This is particularly marked with nitrate production but other elements such as bases and phosphorus are similarly affected[2]. The behaviour of the soil as regards nutrient supply is clearly very different at the start of the rains from what it is later on, and in soil fertility studies this dynamic aspect of nutrient supply must be considered in conjunction with soil data obtained by conventional methods of analysis.

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Effect of Carbon Dioxide on Multiplication of *Fusarium* in Soil

Numerous studies have been made on the effects of carbon dioxide on fungal growth in pure culture, and on substrates other than soil. Since soil is the natural habitat of many fungi, and frequently has carbon dioxide-levels exceeding that present in normal air, it is important that effects of carbon dioxide-enriched air on fungal behaviour in soil be investigated. With the exception of work by Lundegårdh[1] using sterile soil and *Fusarium* species, there is little information available on the effects of carbon dioxide on fungal behaviour in soil. Recently, techniques have been developed[2] for studying *Fusarium* multiplication in natural soil, as indicated by sporulation and increase in number of colonies on soil dilution plates. It was found that carbon dioxide at levels of 2–25 per cent in air for 16–42 hr. frequently stimulated multiplication of *Fusarium oxysporum* f. *cubense*[3]. Studies were initiated with other *Fusarium* species and with carbon-14 dioxide to determine the action of carbon dioxide in stimulating *Fusarium* multiplication. The soil-plate technique[2] was used for studying the effect of carbon dioxide tension on *Fusarium* population as determined by soil dilution plating.

Certain *Fusarium* species in artificially infested loam and sandy loam (*p*H 5·6 and 7·4) were exposed for 42 hr. to normal air and air enriched with 4 per cent carbon dioxide, after moistening the soil with a