EFFECT OF RADIATION ON SOME BIOLOGICAL PROCESSES IN SOILS

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"TO MY LOVELY PARENTS"

بسم الله الرحمن الرحيم

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C O N T E N T S

INTRODUCTION

Treatment of soil with gamma radiation to achieve partial or complete sterilization or to selectively eliminate specific organisms is established as a valuable technique applicable to many aspects of soil research. The recent increasing studies on the effects of ionizing radiation on biological processes have stimulated the investigations of irradiation effects on soil populations. Knowledge so far gained on the microbiology of irradiated soils now permits more reliable experimental procedures and shows some differential effects on soil nitrogen metabolism that may be utilized to advantage.

Nevertheless, our understanding of the way in which radiation disturbs metabolic cycles in the soil ecosystem and upsets the balance between groups of microorganisms is far from complete measurment of the activites of soil organisms should help to release the effects of radiation on soil phosphorus and manganese metabolism.

As little attention had been given to the soil microbial population and their activities as effected with gamma irradiation in Egypt. It was found of interest to investigate the possible changes that might have occured under different doses of gamma irradiation. Thus the aim of the present study was to investigate.

(1) Effect of different doses of gamma radiation on the total count of soil bacteria and fungi.

(2) Effect of gamma radiation on soil Azotobacter and Clostridium.

(3) Effect of gamma radiation on some extractable ions and PH of the soil.

2. REVIEW OF LITERATURE

Treatment of soil with X and γ radiation or an electron beam provides a useful means of partial or complete sterilization for reasearch purposes (Cawse, 1969, Muller, 1968 and Mclaren, 1969) according to the dose applied. Before the extensive development of powerful x-Ray machines, the few pioneering experiments concerned with the response of the soil to radiation were confined to mixing radioactive materials either with soil or with pure cultures of soil microorganisms (Cawse, 1973). By 1939, there was a little further investigation of the response of soil to radiation emitted from the artificial radioisotopes. With the construction of prototype power reactor, Cobalt - 60 could be produced at far less cost and in sufficient quantity to permit the development of large gamma sources, and various aspects of soil irradiation have been presented since 1950, (C.F. from Cawse, 1969). Cobalt - 60 emits two gamma quanta at 1.17 and 1.33 Mev, and has a half-life of 5.6 years.

The present review is consered with the effect of gamma radiation on soil microorganisms, enzymes and some soil properties.

2.1.: Effect of gamma radiation on soil microorganisms and enzymes:

Cawse (1969), reported that the increase in gamma dose will affect the major groups of soil microorganisms and enzymes, he also reported that 0.2 - 0.5 M rad would inactivate the majority of fungi, while 1 - 2 M rad should inactivate all soil bacteria. Enzymes are extermely radioresistant and can easily tolerate 5 M rad. Voets, et. al. (1965), reported that ionizing irradiation (2 M rad) Completely sterilized air dried soil, the enzymatic activities remaining unchanged. However variation in the numbers of organisms present from one soil to another and differences in radiosensitivity make over-generalisation dangerous, (Cawse, 1969). He also showed that use of term "inactivation" may lead to confusion unless it is realised that it refers to prevention of cell proliferation and not to the complete cessation of metabolic activity within the cell. Cawse (1968) showed that Nitrosomonas and Nitrobacter cells can still carry out extensive oxidation of ammonium to nitrate after 1 M rad even though proliferation of the bacteria is prevented by 0.2 M rad. Cawse (1969), reported that analysis for nitrate would not reflect inactivation but only total inhibition, which most probably occurs above 1 M rad.

A similar result would be expected for sulphur oxidising bacteria of the genus Thiobacillus, and these organisms were present in experiments described by Popenoe and Eno (1962), where sulphate production from elemental sulphur was measured after irradiation. Further more, it is known that doses sufficient to inactivate Azotobacter fail to prevent nitrogen fixation (Sokurova, 1956), and that the microbial reduction of nitrate to nitrite proceeds rapidly at 0.8 M rad (Cawse and Crawford, 1967; Cawse and White, 1969 b) this is a dose well above the region of 0.1 - 0.2 M rad required to prevent proliferation.

2.1.1. Fungi:

In general, fungi are the most radiosensitive group of soil microorganisms (Mclaren et. al. 1962; Eno and Popenoe, 1964; Jackson et. al. 1967 and Kashkina & Abaturov, 1967). Stotzky and Mortensen (1959) also showed that fungi in Rifle peat were damaged between 8 - 250 K. rad.

Roberge and Knowles (1968) compared the lethality of radiation towards fungi and bacteria in pine humus and clearly demonstrated that greater susceptibility of fungi Pencillium Spp. and Trichoderma Spp. are particularly sensitive (Kashkina and Abaturov 1967), and 2.5 K. rad was sufficient to reduce viability; in contrast Cladosporium Spp. are relatively radioresistant (Skow 1962; Kashkina and Aboutrov, 1967). Also Sparrow (1973) reported that fungi were more susceptible to radiation damage than the other groups of microorganisms. Shcherobkova et. al. (1975) showed that soil fungi least resistant to the action of gamma irradiation do not grow on agarized soil at a dose of 500 K. rad. Johanson and Osborne (1964) reported that 250 K. rad was sufficient to kill 98% of viable fungal propagules in a Tennessee arable soil, and the few fungi that survived after 0.75-1 M rad were Phoma Supp. Cladosporium herbarum, Saprolegnia Spp. Chloridium Apiculatum and Trichocladium Spp. They also remarked that irradiation of Etowah silt loam enabled the isolation of fungi not normally seen on dilution plates and suggested that doses in the region of 250 K. rad could be used to isolate rare species. Mosse et. al. (1969) found that 800 K. rad applied to silty clay loam was sufficient to eliminate the indigenous Endogone Spp. population, a vesicular-arbuscular mycorrhiza infecting plant roots and causing beneficial increases in growth. He also found that Allium Cepa was grown in such soil it remained nonmycorrhizal even though the medium was not sterile with respect to other organisms. These experiments emphasize the valuable selective property of radiation, an important advantage over heat and chemical treatments. Ishaque et. al. (1971) examined the nitrification by fungi such as Aspergillus spp. and Penicillium Spp. in an acid tea soil from East Pakistan by applying 0.05 - 2 M. rad. Nitrate failed to accumulate in the incubated soil above 250 K. rad, a behaviour that indicated the elimination of fungi, because nitrifying bacteria are capable of oxidizing ammonium in soils exposed to 250 - 750 K. rad (Cawse and White, 1969).

2.1.2. Actinomycetes:

Organisms in the order Actinomycetes appear to be roughly intermediate in radiosensitivity between fungi and true bacteria. Skou (1962), reported that chronic irradiation of actinomycetes cultures established in sterile soil proved that Mycobacterium

Spp, Nocardia corallina and Streptomyces griseus could survive 500 K. rad delivered over 396 days. Monib and Zayed, (1963) reported that streptomycetes showed a lower percentage survival than bacteria immediately after irradiation but proliferated at faster rate during incubation and its number percent exceeded more than nonirradiated soil. Perry, (1970) isolated actinomycetes from soil at Puerto Rican experimental forest that had received 3 K. rad to 1 M. rad - surface dose over 92 days but no damage was evident from measurement of growth and metabolic activity. Dertinger and Jung (1970) found that actinomycetes were entirely absent after 1 M. rad was applied to soil. Also Shcherobkova et. al. (1975) showed that actinomycetes are more resistant than fungi, do not grow on agarized soils at a dose of 750 K. rad.

2.1.3. Bacteria:

Bacteria is the most resistant group to irradiation, it is more resistant than fungi and actinomycetes (Shcherobkova et. al. 1975). Bernard and Geller (1962) reported that proliferation of niterifying bacteria and Azotobacter in soil was virtually eliminated by 100 K. rad acute radiation, but when 380 K. rad was applied