EFFECT OF SOME SOIL CONDITIONERS ON MICROBIAL ACTIVITY IN DESERT SOILS

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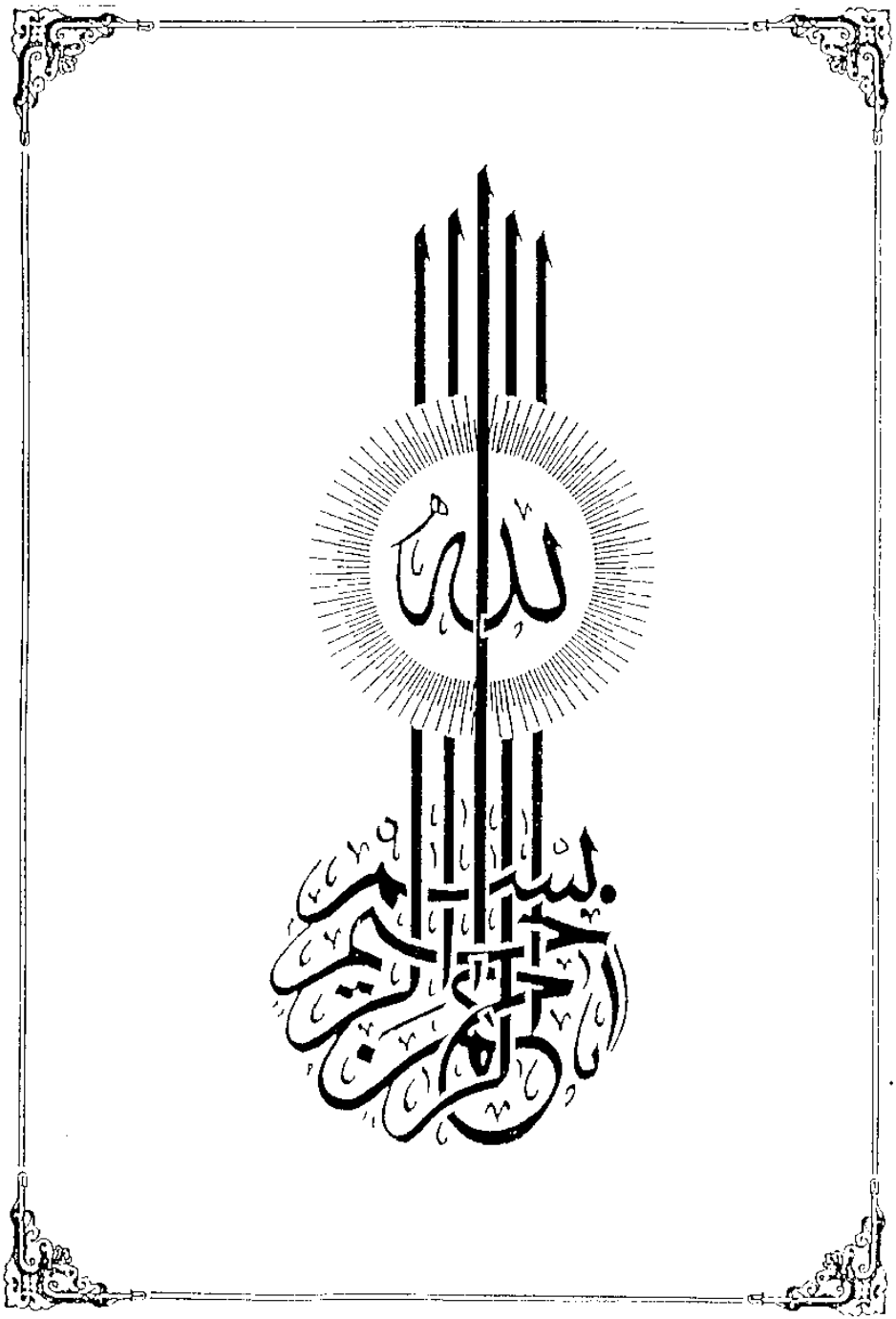

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ARABIC SUMMARY.

INTRODUCTION

In Egypt, the extension of desert reclamation and cultivation has become necessary to increase agricultural production and national income.

However, sandy soils suffur from weak texture and structure, low nutrient and water holding capacity and succeptibility to wind and water erosion. Therefore, special treatments are usually performed to overcome such problems.

Application of clay and organic manures to sandy soils has already been experinced in the past to improve their physical and chemical properties. In calcareous soils, which are widespread in Egyptian desert, addition of organic manures is a common practice to decrease crust formation, fixation of phosphorus and to increase nutrient availability and micro-nutrients supply.

After the construction of Aswan High Dam, the amounts of clay and silt have been diminished. On the other hand, a subsequent high demand of organic matter for soil amendement led to its shortage. Moreover, organic matter should be added more frequently due to its fast decomposition rate under the hot arid climate of the desert.

Consequently, the search for other substitutes has been posed in Egypt to face the deficiency in clay and organic matter. Meanwhile, there has been a growing interest, in

different countries, over the last 30 years in the use of new soil conditioners, whether natural materials or synthetic chemicals. Most of the work done with such conditioners have been focused on their effect on physical and chemical properties of soil.

Until now, the effect of conditioners on soil micro-organisms had not been fully investigated. Only fragmentory studies of this subject have been given. Consequently, the aim of the present work is to study the effect of conditioners on the microbiological activities of soil.

Sandy and Calcareous soils, from western desert of Egypt, were mulched with bitumen emulsion or polyacrylamide as soil conditioners. Barley and then alfalfa were sown in the treated soils. The changes in microbial activities in the conditioned soils were investigated. Some chemical and physical properties of the tested soils were also studied.

1. REVIEW OF LITERATURE

1. 1. Soil conditioners :

1. 1. 1. Definition :

Soil conditioning may be defined as upgrading a poorly-structured soil to one with suitably sized aggregates through proper tillage at the right moisture content and subsequently stabilizing the formed tilth by the application of small amounts, commonly around 0.1%, of synthetic polymers, either dissolved or emulsified in water (DeBoodt, 1979). Depending on the nature of such products the conditioned soil will become either more hydrophobic or more hydrophylic and it may also change colour, with consequent changes in heat absorption (Barnett et al., 1967; Gerard and Chambers, 1967 and Ahmed and Roblin, 1971).

The most important aspect of soil conditioning, however, is its aggergating and stabilizing action. Thus, the function of soil conditioners is analogous to that of humus.

1. 1. 2. Mode of action :

The mechanisms of linkages involved on a molecular level between the soil particles and the long chains of the polymers have been studied extensively; comprehensive accounts are given by Greenland (1965 & 1972).

Briefly, soil conditioners which are cationic or anionic have the property of making either a direct electrostatic linkage with the negatively charged clay surfaces or an electrostatic linkage with the adsorbed divalent or trivalent cations on the clay particles.

Non-ionic conditioners can make linkages with the soil particles either through hydrogen bonds or Van der Waals forces. Examples are the hydrogen bridges either of the OH groups on the edges of the clays with NH_2 groups of the conditioners or the OH groups of the conditioners with the oxygen on the soil particles.

1. 1. 3. Types of soil conditioners :

The first attempt for immediate artificial soil structure improvement was made at a symposium held in Philadelphia on the "Advancement of Science" in December, 1951. There, the personnel of the Monsanto Chemical Company introduced the first soil conditioner known as "Krillium", which is a sodium salt of an acrylnitrile polymer. A new start of research on soil conditioning was given at the Symposium on the "Principles of Soil Conditioning" held in Ghent, Belgium, April, 1972. Now many new products are available on the market as soil conditioners. Examples of the most important soil conditioners are listed in the following,

as reported by De Boodt (1979) :

A). Polymers soluble in water, hydrophilic soil conditioners: Polyvinyl alcohol (PVA), Polyvinyl alcohol, urethanised (PVAu), Sodium polyacrylate (SPA), Polyacrylamide (PAM), Polyvinylpyrrolidone (PVP), Polyethyleneglycol (PEG).

B). Polymers emulsifiable in water, hydrophobic soil conditioners: Polyvinylacetate (PVAc), Polyurethane, Polybutadiene (BUT), Natural rubber latex Asphalt (bitumen).

It should be noticed that, recently some soil conditioners have been locally produced in Egypt such as bitumen emulsion, water-soluble polyacrylamide and urea formaldehyde (El-Sherif, 1987).

1. 1. 4. Specific requirements :

Specific requirements for polymers substances in-order to be useful as soil conditioners (Schamp, 1976) may be summarized in the following points :

1. Compound has to possess good adhesive properties.
2. Compound have to be homogeneously introduced into the soil as powder or distributed in water as a solution or as an emulsion.
3. After conditioning, soil aggregates should be stable in water.

4. Products should not be phytotoxic.
5. Life-time has to last long.

The important aspects of soil conditioning may be one of the following :

1. If the soil is poorly aggregated, aggregates can be formed by mixing the material with the soil.
2. If unstable surface clods are already formed, the soil conditioner can be sprayed over the surface to act as a protective film against runoff.

1. 2. Effect of soil conditioners on some biological activities :

The interaction between soil conditioners and soil microflora had been studied by some investigators from different points ofview. Some researchers focused their work on the role of microorganisms in the breakdown of such conditioners. Others, studied the stimulatory or inhibitory effects of conditioners on the different groups of soil microflora, particularly those important for soil fertility. In addition, the effects of conditioners on soil enzymes had attained an attention by some other investigators.

Consequently, the main results of researchs of each of the above three topics will be summarized in the following review :

1. 2. 1. Microbial degradation of soil conditioners :

Studies on bitumen biodegradation had been given by Harris (1956) and Harris et al., (1956). They reported that the partial degradation of bitumen can be brought about by some soil microorganisms. The most active genera were found to be Pseudomonas, Micrococcus, Flavobacterium and Mycobacterium.

The decomposition of bitumen road building materials was also investigated by Burgess (1956) who suggested different means for the reduction of microbial decomposition by appling more effective underseals to prevent soil moisture from contacting the bitumen. Burgess further suggested the employment of chlorinated bitumen to inhibit microbial attack.

Phillips and Thaxler (1963) studied the utilization of bitumen by some soil microorganisms in pure culture. They noted that soil isolated Pseudomonas 1-5 A-C during one month utilized 90% although the stock culture was more active in the first week of incubation.

Harris (1964) noted that bacteria capable of utilizing hydrocarbon were present in much greater numbers in soil adjacent to bitumen coated pipelines. He observed a correlation between high population of hydrocarbon utilizing soil bacteria and deteriorating bitumen coatings on buried pipe. He also found experimentally that bitumenous material continues to be utilized by bacteria over long periods. After a maximum bacterial population developed in laboratory the cultures were replaced by a fresh mineral salts medium and a new population developed. These experiments were continued for more than 2 years with steady production of new bacterial cells on bitumen coatings.

Harris (1964) stated that bacteria which utilize bitumen coatings are typically representative of hydrocarbon oxidizing microorganisms commonly isolated from soil. These include micrococci, Pseudomonas, Corynebacteria, and Actinomycets. The susceptibility of bitumen coatings to microbial oxidation may be observed by oxygen uptake measurements compared with soil alone. Respirometer technique was employed in which soil (control) or soil plus the bitumen coating was added to flasks attached to sensitive manometers for measuring oxygen uptake.

Hoflich et al., (1974) found that bitumen decomposition in the soil proceeded slowly. Various bitumen concentrations at rates of 2, 6, 20 and 60 l/ha, showed different rates of decomposition. Addition of nitrogen (NH_4NO_3) and natural UV irradiation under field conditions did not influence the rate of bitumen decomposition. Certain correlation were indicated to exist between bitumen decomposition and bacterial development. Increased application of bitumen resulted in higher bacterial counts and stimulated respiration.

Young and Harris (1975) investigated the biodegradability of polyvinyl alcohol and polyvinyl acetate. They found that polyvinyl alcohol and polyvinyl acetate could support the growth of microorganisms to a limited extent.