STUDIES ON BEHAVIOUR OF SOME POLYMERS AND THEIR EFFECTS ON CERTAIN SOIL FEATURES

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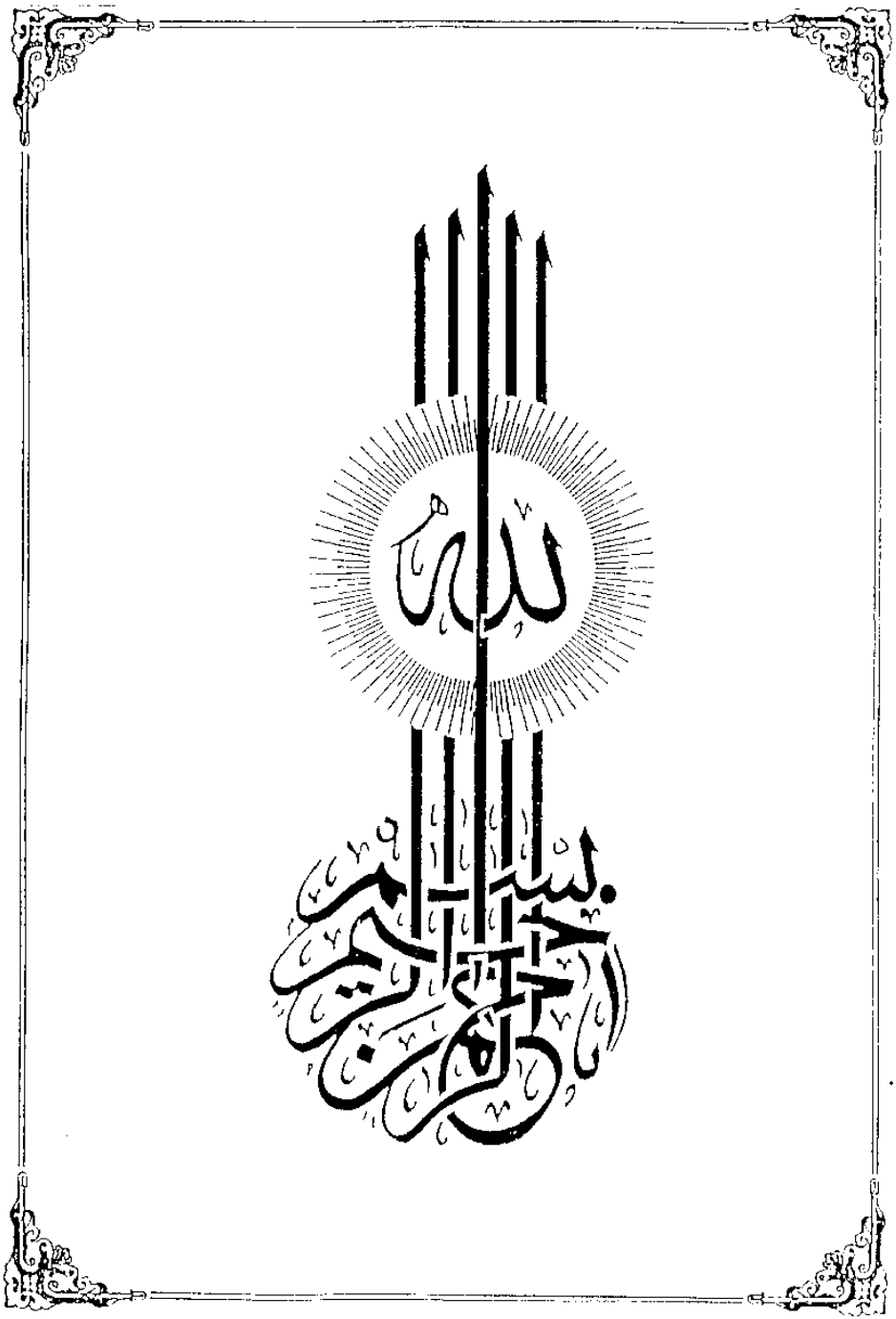

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1. INTRODUCTION

The ultimate objective of scientific research work in the field of agriculture is to find more effective means for increasing the efficiencey of agricultural production as rapidly as the rate of population increase requires. This necessary increase in agricultural production is frequently found to come from an increase in yields per feddan rather than expansion in acreage.

One of the approaches offered to increase the crop yield per unit area is the improvement of soil features particularly those of physiochemical nature, such approach being possibly achieved through application of certain polymers known as soil conditioners.

Soil conditioning means improvement and sustainment of soil physical conditions by using small amounts of specific natural or artificial polymer products. Of course, such conditioning should be reflected on soil characterstics including status of moisture along with chemical and biological reactions involving nutrient behaviour.

The present investigation has been performed as a trial to solve some problems encountered with both

sandy and calcareous soils through application of particular types of artificial polymer conditioners. Evaluation has been carried out for changes in soil charactarestics upon addition of poly acrylamide (PAM), polyvinyl alcohol (PVA), and poly vinyl acetate (PVAc) polymers; such charactarestics included physical, chemical and biological featurs with special reference to physiochemical ones.

2. REVIEW OF LITERATURE

According to Tager (1978), polymers are compounds formed by a more or less regular repetition of a large number of the same but different atomic groupings that are joined by chemical bonds in long chains having side branches. The number of repeating units in the chain is called degree of polymerization and donoted by the letter (n) or (P). The product of the degree of polymerization (n) and molecular mass of a monomeric unit (Mu) equals the molecular mass of the polymer: $M_{pol.}$ = n. Mu. Copolymers or mixed polymers are polymers containing several types of monomeric units in their chains.

In the last few years, many investigations have paid attention to polymers of synthetic soil conditioners as a field of research and practical application.

De Boodt (1972) reported that to obtain good aggregation with heavy soils, polymers of a few hundreds or thousands of melecules are more appropriate. The two materials initially introduced were vinyl acetate maleic acid (VAMA or CRD - 186) and hydrolized

polyacrylonitrile (HPAN or CRD - 189); VAMA and its various formulations were called "Krilium". The author added that the polymers and related products variously proposed for soil conditioning can be classified as follows:

a. Non-ionized polymers such as polyvinyl alcohol (PVA).

b. Polyanions polymers such as polyvinyl acetate (PVAc), polyacrylic acid (PAA) and vinyl acetate maleic acid copolymer (VAMA).

c. Polycations polymers such as Dimethyl amino ethyl meta crylate (DAEMA).

d. Strong dipole polymers inducing positive or negative bonds such as polyacrylamide (PAM).

e. Bitumen emulsions.

2.1. Synthetic polymer products as soil conditioners:

De Boodt (1978) reported that the main objects of using soil conditioners are promoting germination in soils, enhancement for infiltration, fighting wind and water erosion, blocking fertilizer displacement in and from soils subjected to heavy rain and cutting

evaporation from the top layer in semiarid and arid regions.

2.1.1. Polyacrylamide solution (PAM).

De Boodt et al. (1972) reported that all solution polymers appeared to consist of a complex filmy and fibrous network having a thread-like structure binding the soil particles together by strands of conditioner materials. Gabriels et al. (1975) added that when PAM is used as a polymer solution, it remains non-soluble in the soil. In fact, since the monomer costs less than third of the dry polymer, efforts have been made to induce polymerization in the soil. The monomer as such can not be used, however, as soil conditioner due to its toxic effect on plants. The authors added that to know how the best results can be obtained When using PAM as a soil conditioner, a series of preliminary laboratory experiments are necessary.

Vandevelde and De Boodt (1972) showed that when 100 cc of a 2% PAM solution was added to a sandy clay soil having amoisture content of 15% by weight, an optimal aggregate formation and stability were obtained.

Ildefonso (1975) added that treatment with PAM produces a higher proportion of relatively small water stable aggregates, its maintenance in the surface soil being less effective on water intake rates and to evaporation losses of the water stored in the soil.

As regards to effect on grown plants, Anter and De Boodt (1976) observed that the uptake of Ca in the PAM treatments was more or less the same as in the control ones. This was true in spite of the favourable effects of PAM application on the Ca concentration within plant tissues. Hartmann et al.(1976)added that application of either PAM or PAM + glyoxal favoured the availability to plant roots of water from relatively high depth, evaporation rate being influenced through effects on the contact angle of the soil. The upward forces due to capillarity was less for treated sandy soil, which has a higher contact angle, than for the untreated one. Accordingly, a thicker layer of dry mulch could be formed more rapidly.

Under local conditions, Tayel and Anter (1978) found that all used conditioners increase the aggregate stability when compared with the untreated soils,

the aggregate stability being increased progressively with increasing the application rate of conditioners such as PAM.

2.1.2. Polyvinyl alcohol solution (PVA).

A number of uncharged synthetic organic polymers have been reported by Blavia et al. (1971), polyvinyl alcohol (PVA) being proved to be at least as effective as other compounds. Stefanson (1973) added that such conditioner has been shown to be an effective stabilizer for surface soil when the structural organization of soil is maintained by the soil organic matter. In three out of four studied soils, the acceptance of simulated rain could be doubled by adding 0.005% w/w of PVA to the 0 - 2 cm surface layer of soil in an undisturbed core. The same author (1975) studied the fate of (PVA) in soils and found that both wheat and pasture roots reduced the effective stabilization of surface soils created by PVA. After 2.5 years of incubation, PVA and components of its breakdown in soils were still successfully stabilizing the surface of the cores.

Gabriels and De Boodt (1976) pointed out that the drawback of using PVA is the necessity to be

warmed up to 700° in order to get into solution. Anter and De Boodt (1976) added that the increasing of PVA concentration over 0.1 decreases the seed germination obviously.

2.1.3. Polyvinyl acetate (PVAc) emulsion.

Gabriels and De Boodt (1974) studied the percentage of aggregates and stability index for sand dunes treated with curasol AE (PVAc) at different concentrations of 0.5%, 1% and 1.5%, treatment carried out at various initial moisture contents (I.M.C) but total moisture content being kept at 20%. The I.M.C of soil had no significant influence on the aggregate percentage and aggregate stability. In spite of that, addition of tylose (1%) increased the formation of aggregates with no effect on their stability, probably due to leaching out of carboxy-methyl sodium-cellulose. Indicated results agree with those of Gabriels and De Boodt (1975) who observed that the aggregates were not entirely stabilized by means of polyvinyl acetate conditioner. Large amounts of soil were splashed away, plugging the pores and causing a high runoff rate although little soil loss was observed. The surface

treatment with 50 - 100 cc PVAc/m^2 relatively prevented slaking and hence maintained a relatively high water infiltration-rate. Gabriels and De Boodt (1976) added that on a heavy sandy Loam, 6500 l/ha curasol AE (0.5%) is needed for good results with regared to soil loss, the same results being possibly observed with some PAM products at a dilution of 0.13%.

Anter and De Boodt (1976) mentioned that dry matter content of corn plants showed no obvious response to increasing the PVAc concentration. Tayel and Anter (1978), however, added that aggregate stability increased with increasing the application rate of PVAc, PAM and PVA synthetic soil conditioners.

2.2. Polymerization and behaviour of synthetic polymers in soil:

2.2.1. Bonding energy and polymerization.

The ability of an element to form polymeric compounds was reported by Tager (1978) to depend on its possition in the mendeleev periodic system. The elements of group one along with univalents of other groups are entirely incapable of forming polymers. An element must