THE APPLICATION OF STRUCTURE FACTOR AS AN AID FOR RECLAIMING AND IMPROVING ALKALI SOILS IN THE U.A.R.

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1. Introduction

Wide spreading of sodic-salinization of soils all over the world in countries of different climates and in countries economically differently constructed and developed motivates to examine the formation of sodic-alkalization and to promote the amelioration of these soils. This is notably the case as sodic-alkalization hinders agricultural production or even makes it impossible. Soda formation often leads to the destruction of agricultural production and to great economic damages especially on irrigated land. Owing to the intense alkalinity and extremely unfavourable physical properties, alkali soils have exceptionally poor natural fertility. Arabs were familiar with soda and alkali soils from very early times. In fact it was from Arabic that the word "alkali" passed first into Western European and then into American geological and pedological terminology (Kovda 1964).

In Egypt, as long as the previous system of overflooding irrigation system was practised, alkali was not a serious problem in the Nile Delta, except in the low-lying areas adjacent to the Mediterranean. However, after the completion of the Barrage in 1895 across the Nile above the confluence of the Rosetta and Damietta branches, perennial irrigation replaced the ancient system of the one annual flooding, and soon thereafter salinity and alkalinity began to appear here and there in the Delta and some regions of Middle Egypt. According to the data of the soil survey and Land Classification Division. Ministry of Agriculture, U.A.R., the alkali area in Kalioubia, Menoufia and Minia Governorates amount to 2908, 4181 and 10253 feddans respectively which makes about 1.34, 1.14 and 1.94 % of the total area in the three provinces respectively. Moreover, the construction of the great dam at Aswan has made possible expansion of the irrigated area, as well as an intensive irrigation of the Delta. Unfortunately, this will lead to considerable complications of the alkali problem in both the Delta and Nile Valley. According to the successive increase in population, the need for agricultural products increased and the demand for the maximum yields from the whole area including alkali ones became greater.

Vegeler and Alten (1931) after Lehmermann during their work on the Nile alluvial soils in the Sudan suggested the use of "structure factor".

The reclamation of alkalinity of alluvial soils in the U.A.R. is subjected to some difficulties, first of all, the critical limits of alkali soils, second, the estimation of gypsum requirements. However, the effect of exchangeable sodium varies from soil to soil, as well as, the physical properties of fine-textured soils are affected more adversely at a given exchangeable sodium percentage than coarse-textured ones. Furthermore, by establishing an equal degree of sodium saturation, soils of similar texture but of different series have often shown rather wide differences in permeability.

The current work was conducted to examin the suitability of the structure factor as a reliable criterion for the diagnosis and evaluation of alkali soils. Besides a trial was undertaken to utilize that reliable criterion, i.e. the structure factor in calculating the gypsum needed for reclaiming and improving the physical properties of alkali soils. In addition, a comparison had been conducted between the structure factor and the imperical methods for estimating the gypsum requirements for removing alkalinity from alkali soils.

2. Review of Literature

The major problem of alkali soils is the deterioration of its physical properties especially its structure. This deterioration leads to the formation of massive structure which is unfavorable for irrigation or drainage and causes a low water permeability. Therefore, it was convenient to discuss the soil structure under the following subheading.

2.1 Quantitative characterization.

2.2 Structure formation.

2.1 Quantitative characterization

A complete quantitative characterization of soil structure would involve evaluation of the size and shape of the structural units, the strength of the interparticle bonds within and between units and the size distribution and continuety of pore spaces within and between units. The structure of a soil involves a summation of these characteristics in the soil profile. Soil structure is, therefore a complex phenomenon that cannot be characterized precisely by a single physical measurement. Quantitative methods in use at present evaluate only a portion of the overall phenomenon.

Probably the most widely used measurement of soil structure is the so-called aggregate analysis. An aggregate soil analysis aims to measure the percentage of water-stable secondary particles and the extent to which the fine mechanical separates are aggregated into coarser fractions. In general, three techniques are employed to accomplish such an analysis, wet and dry sieving, elutriation, and sedimentation. Direct dry sieving of soil particles as they occur in the field has been used by Keen (1933), Cole (1939) to evaluate the distribution of clods and aggregates. Tiulin (1928), has suggested that sieving in benzene or xylene achieves similar results to dry sieving. The wet sieving technique of Tiulin is the best known of the earlier endeavours to find a measure of soil aggregation. The most widely spread technique consists in sieving aggregates under water. This method became well established by Tiulin (1933), Yoder (1936) and Meyer and von Rennenkampff (1936). The method consists in obtaining a relative movement of the water versus the aggregates. Yoder whose procedure is the origin of many stability determinations, used his method to study the erodibility of the soil and not the aggregate stability. The committee on physical analysis of the Soil Science Society of America (1953), described the essential features of the aggregate stability determination through wet sieving (more or less the same as the Yoder method), leaving the possibilities of a great number of minor variations in the procedure. Although called an aggregate stability method, it is only a procedure to measure the aggregate distribution of a soil after wet sieving. As there is no comparison made between the obtained wet stable aggregates and the initial dry aggregate distribution, there is, in the opinion of De Leenheer and De Boodt (1959), not an actual aggregate stability measurement, although a stability determination is involved through that does not require the use of Stoke's law for determining hydraulic or settling velocities.

Sedimentation methods have been used to determine the aggregate distribution in the fine fractions that cannot be separated by sieving. The pipette and hydrometer techniques have been used. Cole and Edlefsen (1935) have criticized wet sieving and elutriation on the basis that the action of water disperses many of the aggregates.

The usual practice in calculating the state of aggregation of a soil is to make an analysis of the sample, with and without dispersion. The total weight of a given fraction in the undispersed state minus the weight of the same fraction when completely dispersed is taken as the quantity of aggregates in the soil having that particular size. For example, if the wet-sieving technique is used, the aggregated sample is passed through the nest of sieves, the weight of material on each screen represents the aggregates plus mechanical separates of this size. Then the completely dispersed sample is passed through to determine the weight of the mechanical separates in each size range. The percentage of aggregation is obtained from the difference between the two distribution curves. It should be mentioned, however, that a certain error is introduced into the calculations in this technique. Tiulin (1928) has suggested that only those aggregates that are larger than 0.25 mm. in diameter are responsible for stable soil structure. The percentage of aggregates larger than 0.05 mm. has been used to characterize the "state of aggregation" of the soil. This lower limit was chosen on the basis that aggregate and mechanical analyses curves intersect near this point, which makes it impossible to determine aggregates smaller than 0.05 mm. from the two curves. Some investigators as mentioned by Baver (1956) have employed sizes ranging from 0.002 to 1 mm. in order to express the percentage soil aggregation.

Middleton (1930) has suggested the dispersion ratio as a measure of aggregation which represents the percentage of particles smaller than 0.05 mm. in the aggregated sample divided by the percentage of particles of the same size in the dispersed sample. The lower this ratio, the greater is the percentage aggregation of the silt and clay. Vageler and Alten (1931) had employed the same principle but using 0.002 mm. as the size limit. It has been recommended that the percentage of mechanical separates, smaller than either 0.05 or 0.1 mm., which are aggregated into secondary particles larger than this size can be used to express the degree of aggregation. Accordingly, it could be then possible to distinguish between the total percentage of aggregates or state of aggregation and the degree of aggregation of the fine mechanical separates. During their work on the Nile alluvial soils in Sudan they had used the "structure factor" which is obtained by subtracting the percentage of clay without dispersion from its percentage after complete dispersion and dividing by the latter percentage, and the result is multiplied by 100. This factor ranges between zero and 100, when it approaches zero the soil is poorly structured and vice versa. Recent work carried out by

Milad (1963) to study the suitability of different methods for estimating the stability of microaggregates in the Nile alluvial soils led to the conclusion that the structure factor used by Vageler could be considered the best method for measuring the soil structure. Alderfer and Merkle (1941), had suggested a single value designated as the stability index which is the sum of the positive differences between the aggregate analysis and the complete mechanical analysis. The larger the stability index, the more stable is the structure of the soil. Van Bavel (1949) suggested the mean weight diameter of the soil aggregates as a statistical index of aggregation. The mean weight-diameter is measured graphically from the area under the curve showing the accumulated percentage by weight of different sizes of aggregates. It gives an estimate of the average size of the soil aggregates and permits the presentation of an aggregate analysis in one figure. He found it to be a sensitive indicator of the condition and treatment of the soil. Other methods expressing the structure capacity of the soil include the use of certain physicochemical properties along with the percentage of aggregates. Most of these expressions aim at the same objective, namely, to characterize soil aggregation on the basis of how many aggregates are present and to what extent the silt and clay are aggregated.

this does not happen for 100 percent of the charge, so a flocculating micro-aggregate will have a residual electric charge, which is important for the flocculation of larger aggregates, Katschinski (1958). The addition of salts to a colloidal solution is a well known way for reducing the electrokinetic potential difference in the electric double layer or Gouy-layer enveloping every charged particle, and in some cases it is possible to change the sign of the initial electric charge of the colloidal, Freundlich (1930). The stability of the flocculation of the elementary particles depends mainly on three factors, Leenheer and Boodt (1966) namely the size and structure of the elementary particles, the physico-chemical properties of the electric double layer of the colloids and the chemical stabilization of the aggregates and the binding forces of organic and mineral particles. Martin et al (1955) cited that "Polar organic compounds may be thought of as playing two important roles in soil structure tending to stabilize naturally formed aggregates; (1) weaking the strong cohesive bonds between clay particles, thus permitting formation into aggregates instead of a solid mass; and (2) linking clay particles together through mutual adsorption of such compounds by two or more clay particles. There is insufficient evidence available to indicate which of these two functions is the more important. It is almost certain, however, that both are important and that both actions may occur concurrently in stabilizing soil structure. Recent work has shown that highly polymerized straight-chain compounds are extremely tightly held by clays. They do not appear to be replaced by ordinary exchange and