PHYSICAL AND WATER ECONOMICAL PROPERTIES OF THE SOILS IN SOME TYPICAL ALKALI SOILS

By

ANIS EL-SAID MOHAMED IBRAHIM

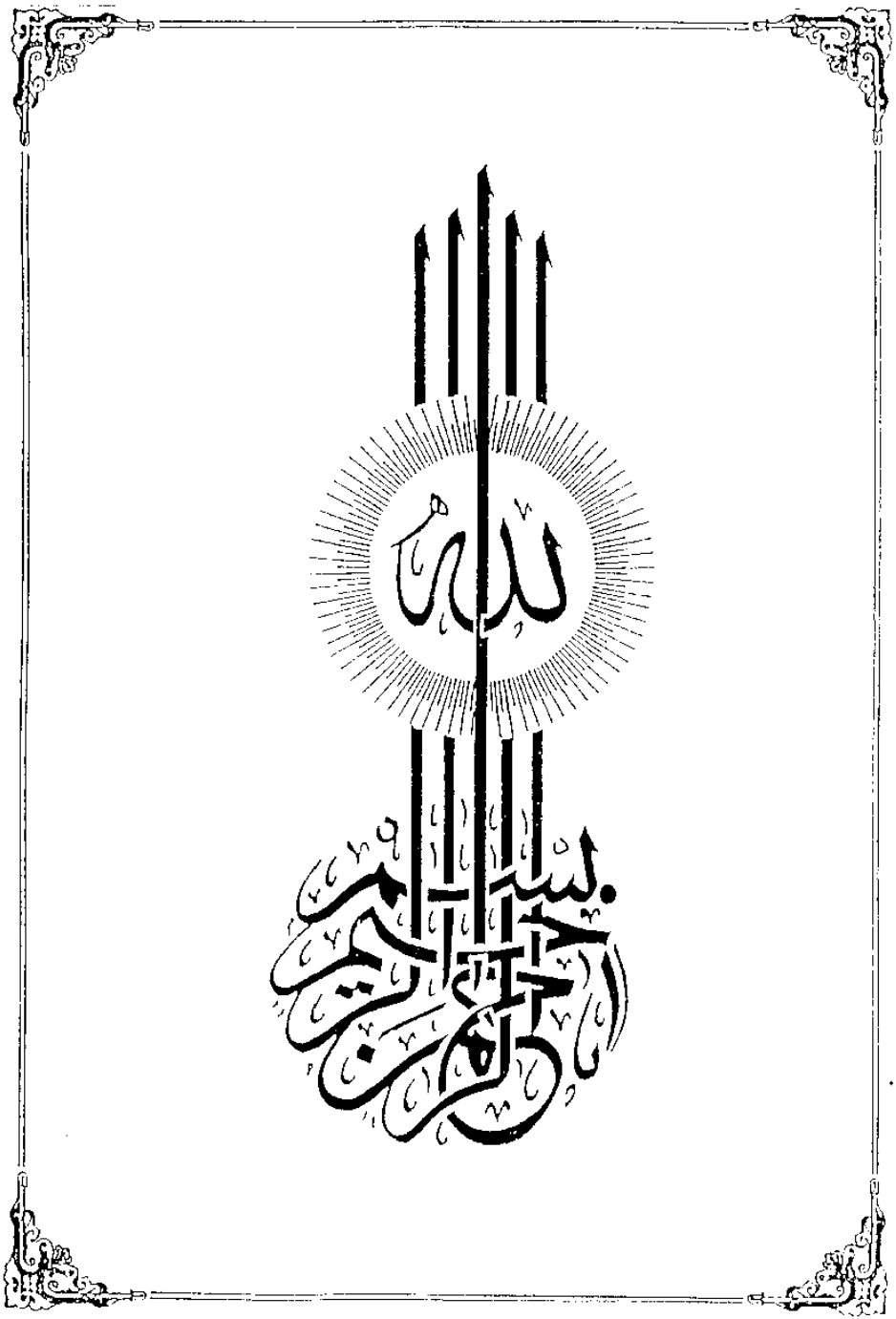
B. Sc (Agric.). University of Cairo 1967

Thesis

Submitted in Partial Fulfilment of the Requirements
for the Degree of
MASTER OF SCIENCE
in
SOILS

in the
Faculty of Agriculture
Ain Shams University

1974



LIST OF TABLES

&&&

---

1. INTRODUCTION

The anticipated increase in population and agricultural demand for land and water resources necessitate, much more efficient use to those resources than currently exists. So, the prominent aim of A.R.E. aggravate policy to meet the increase of population is to increase the land production through better land-use and improvement of agricultural techniques.

It is well established that the permanent and occasional deterioration of the alluvial soils, saline and alkali soils, is mainly due to the involving hydraulic conditions. Numerous channels and streams with perennial irrigation have caused a considerable rise of the underground water-table.

The development of a high water-table level, abscence of field drainage, and heavy texture of the soil caused a subsequent rise and accumulation of soluble salts through capillarity to the upper soil layers which may efflorescence on the surface. This phenomenon is still going on, and it is obvious that the salinity and alkalinity problems will continue to affect crop production.

Accordingly, a great part of the cultivated area is considered saline or saline-alkali or alkali soils owing to the recent soil survey data.

Therefore, the objective of this investigation is to study some physical properties of deteriorated soils (salt-affected soils) on one hand, and the relation with their chemical properties and soil-water relationship on the other hand.

2. REVIEW OF LITERATURE

2.1- Graphical distribution of salt-affected soils, and conceptions of their classification.

Salt-affected soils are found in cold, temperate, sub-tropical and tropical belts, coincide with lake and river terraces, young ancient alluvial plains, deluvial, in depressions and also occasionally, on high mountain plateaux, in regions which have a continental or arid climate, in the brown and chestnut soils of the warm belt; the red earths and black cotton soils. It could be concluded that they are distributed all over the world (De'Sigmond, 1924; Raychaudhuri, 1954; Kovda, 1958; Egarov, 1961 and Kovda, 1964).

In A.R.E., there are many studies on salt - affected soils (Gracie et al., 1934; Abd El-Bar, 1942; Kor Kor, 1961; Abbas, 1965; El-Zeftawy, 1968; Hamdi et al., 1968 and Shabassy et al., 1969).

El-Gabaly (1972) mentioned that salt-affected soils in Egypt are located in the northern central part of the Nile Delta and on its eastern and western

sides. Such areas are found in Wadi El - Natron, El-Dal-El-Kebir, the oases, many parts of the Nile Delta and valley and El-Fayoum province. Soils of primary salinity are mainly those of marine and lacustrine origin, such as brakish lake beds or salt marshes along the northern coast. Soils of Edko, Mariut, and Burullus are examples of this type; these soils are saline or saline-alkali with sodium chloride and sulphate as dominant salts. In Fayoum, the salinization took place as a result of the deposition of the migrating salt during the soil formation. The salinity in El-Wadi El Gedid and Kattara depression lands is generally connected with the evaporation of deep salty ground water. It can be concluded that the salt - affected soils of secondary origin, in Egypt, are in the old cultivated areas, and are more pronounced in low laying lands adjacent to irrigation canals.

In the United States of America the staff of the Salinity Laboratory (1954) classified the salt-affected soils into three groups.

1- Saline soils: Saline is used in connection with soils for which the conductivity of saturation

extract is more than 4 mmhos/cm. at 25°C. and the exchangeable sodium percentage (ESP) is less than 15. These soils are generally flocculated.

2- Saline-alkali soils: Saline-alkali is applied to soils for which the conductivity of the saturation extract is greater than 4 mmhos/cm. at 25°C. and the ESP is greater than 15. Under conditions of excess salts, the pH readings are seldom higher than 8.5 and the particles remain flocculated.

3- Nonsaline-alkali soils: Nonsaline-alkali is applied to soils in which the ESP is greater than 15 and the conductivity of the saturation extract is less than 4 mmhos/cm. at 25°C. The pH readings usually range between 8.5 and 10. These soils frequently occur in semi-arid regions in small irregular areas, which are often refered to as " slick spots" . Nonsaline-alkali soils in some areas of western U.S.A. have ESP considerably above 15, and yet the pH readings, especially in the surface soils, may be as low as 6. These soils have been refered to by De'Sigmond (1938) as degraded alkali soils.

Owing to the Russian classification, alkali soils occur in various climatic zones. They originate usually in topographic situations similar to those in which swamp and meadow land soils develop. This occurrence is especially true of those of alkali soils known in the Russian literature as structureless alkali soils and in recent times as "Solonchak" (Gedroiz 1923).

In addition to the structureless alkali soils, Russian investigators have described another variety with well defined structure known as "Solonetz".

Associated with the fully developed numbers of the groups chernozem, chestnut, brown and grey soils, one may find soils which represent transition stages between both kinds of alkali (solonchak and solonetz).

Aside from these classes, the Russian investigators define another kind of alkali soils called solodi or degraded alkali. Gedroiz (1923) proposed a system of soil classification that placed the main emphasis on the chemical composition of the colloidal particles of soil and his main groups are as follows:-

1- Soils saturated with bases under which there are:

a) Ca-Mg saturated, like chernozems.

b) Na- saturated - like saline and alkali soils.

2- Soils unsaturated with bases that include:

a) Wide silica-alumina ratio (Podzols)

b) Narrow silica-alumina ratio as the laterite, yellow and red soils.

In A.R.E., several conceptions of classification may be presented as follows:-

At the beginning of this century, attention was drawn to the deterioration of the fertile soils of the Delta due naturally to the accumulation of soluble salts. The excess of irrigation water and the imperfect drainage system were the major factors in the development of such soils.

In dealing with the deterioration of land under perennial irrigation, Gracie et al. (1934) drew attention to that type of soils on which nothing at all can be induced to grow. Such completely infertile soils generally occur in more or less isolated patches which may extend from a square meter up to many feddans in area. In some parts or in the whole of their profiles they are in a highly dispersed condition and are, as a

result of this, practically completely impermeable to water. From field and laboratory observations made on profiles taken from such spots, they can be classified into two types which appeared, at first sight, to be sharply distinct, except for the common properties of impermeability of water and consequent infertility; black alkali and gypsum veined soils.

Comparing with the surrounding fertile soils, from which it is derived, a "black alkali" soil, in addition to its impermeability, show the following features:-

a) The dominant exchangeable bases have become sodium instead of Ca^{++} and Mg^{++}.

b) There is a very marked increase in insoluble Ca- and Mg-compounds; the calcium has been deposited mainly as carbonate and the magnesium as silicate.

c) The amount of organic matter in the profile has been greatly reduced.

d) The soluble salt content is low, but the carbonate, and bicarbonate titration of the water extract is abnormally high.

e) Analysis of the clay separated from various horizons of such soils brings out a significantly higher silica + magnesium content as compared with normal soils.

f) In the field, a black skin of organic matter (sodium humate) is sometimes present at the surface.

According to the Russian scheme of classification of alkali soils, the type here described as black alkali, would correspond to a "solonetz", which with exception of the structure all of the aforementioned features with the black alkali soils of Egypt held in common with the solonetz (Kor Kor 1961).

The gypsum-veined soils, appeared at first to have a common with the "black alkali" only their infertility and impermeability to water. In Egypt, they are not analogous to the "degraded" solonetz. They cannot have arisen secondarily through the regarding of pre-existing "black alkali" soils since they are sharply distinguished from the latter in that their contents of calcium carbonate and organic matter in the profiles remain entirely normal, while the increase in insoluble

magnesium may be relatively high.

2.2- Some factors affecting the formation of salt-affected soils.

2.2.1- Geomorphological and geological factors.

Many investigators have studied the effect of soil morphology and soil geology on salinity problems.

De'Sigmond (1936) as well as Kovda et al. (1967) found that the macrorelief is found in the mountains and terraces in which the differences in soil altitude are high. The mesorelief has relatively small differences in altitude (1 to 2 m.) which are sufficient to make the salt content completely different from that of adjacent lands. The salinity problems appear in depressions whereas the soil on the higher parts of the macro-and mesorelief are invariably less saline. De'Sigmond attributed the accumulation of salts to the effect of the subsoil water table being continuously so high that the various sodium salts cannot be removed by natural drainage, owing to the impervious subsoil preventing the leaching out of sodium salts and to evaporation of soil moisture.