EFFECT OF TILE DRAINAGE ON SOIL PROPERTIES IN MENOFEYA GOVERNORATE

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B.Sc. (Agric.)

University of Ain Shams 1969

THESIS

Submitted in Partial fullfilment of the Requirements
for the degree of

MASTER OF AGRICULTURAL SCIENCE
(Soils)

in

Graduate Division of the
University of Ain Shams

1972

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بسم الله الرحمن الرحيم

ACKNOWLEDGEMENT

The author wishes to express his deep gratitude for Dr. Abdel Halim El-Damaty, Professor of Soil Science and vice-Dean of the Faculty of Agriculture, Ain Shams University, Dr. Kamal Shaaban, Associate Professor of Soil Science, Faculty of Agriculture(Shebein El Koum), Ain Shams University and Dr. Adel El-Leboudi, Associate Professor of Soil Science, Faculty of Agriculture, Ain Shams University for their supervision, continuous help and introducing all facilities needed throughout the whole investigation and during writing the manuscript.

The author wishes to extend his thanks to all staff members of the section of tile drainage maintainence, Ministry of Irrigation at Menofeya Governorate for introducing certain facilities needed.

Special gratitudes are introduced to the author's father who always tried and still introducing all his best for his son throughout his life.

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I. INTRODUCTION

Due to the basin system of irrigation undertaken for one crop yearly rotation, the soils of Egypt were well known along thousands of years ago to be of highly productive nature. In spite of that and according to the increase of population and limited cultivable area, it was necessary to make the crop rotation as to be permissible for more than one crop per year. Therefore, the basin irrigation design was substituted with permanent system. As permanent system of irrigation is always known to be connected with relatively high moisture conditions, the problem of field drainage was arised to be solved by different systems either as open drains or as underground tiles.

Since wood, stones and gravels had been used in filling certain drainage passages, installment of tile drainage had been initiated within the 15th century. According to several field investigations, locally carried out in Egypt, the application of tile drainage was established in twenty thousands feddans of Menofeya Governorate to be gradually expanded through almost the whole area of that Governorate Therefore the aim of this investigation was to study the effect of the installment of tile drains on soil characteristics in certain areas of Menofeya Governorate which were subjected to relatively impeded drainage conditions.

II. REVIEW OF LITERATURE

The effect of drainage on features of soils was investigated by many workers. To follow easily the review on this subject, it seems better to introduce such data under different subheadings.

1. Drainage and physical properties of soil.
2. Drainage and chemical aspects and movement of salt solutions through and out of soil profiles.

II.1. Drainage and Physical Properties of Soil.

The soils of Egypt are considered by most investigators such as Bell (1939) to be of alluvial nature that were and still formed from mud sedimentation of the River Nile and its canals. Labib (1960) reported that the fine clay fraction in the soil profile slightly increased with depth. This refered to the migration of clay fraction with the irrigation water from the upper layers and its sedimentation in the deeper ones.

Several investigations were carried out for defining the status of calcium carbonate in the alluvial soils of

Abdel-Aal (1961), in a pedological study on a farm at Moshtohor, Kaliobia Governorate, found that the calcium carbonate content in soil fluctuated between 4.1 and 5.2%.

In a discussion for the status of $CaCO_3$ in the alluvial soils of the U.A.R., Zeinel-Abedine *et al.* (1966) reported that the mainly two sources of $CaCO_3$ in the Nile alluvium were the fine particles of $CaCO_3$ mixed with Nile suspended matter. He added that $CaCO_3$ could be formed through transformation of $Ca(HCO_3)_2$, usually found in irrigation water and soil solution in variable quantities, into $CaCO_3$. He added that these soluble carbonates might accumulate in the surface layers as a result of the evaporation of soil water in clay soils having low permeability.

Several investigations were carried out for evaluation of bulk density in the alluvial soils.

El-Shal (1953) found that the bulk density in Menofeya Governorate soils was 1.11 g/cm^3 in the 0-10 cm layer; it increased with depth up to 1.45 g/cm^3 in the 50-70 cm. layer.

Bithai (1961) found that the average bulk density for soil before ploughing varied between 1.14 and 1.25 g/cm^3 in the 0-13 cm layer, and between 1.33 and 1.41 g/cm^3 in the 13-25 cm layer. After the first ploughing, it fluctuated between 0.9 and 1.07 g/cm^3 in the 0-13 cm layer and between 0.99 and 1.36 g/cm^3 in the 13-25 cm layer.

Moisture conditions usually have much to do with the bulk density of soil.

Brill and Black (1958) studied the residual effect of irrigation on soil physical properties. They showed that the bulk density increased by irrigation.

Akatsuka, et al. (1965) studied the effect of tile drains on the bulk density of heavy clay soils. He showed that the drains 1 m deep at intervals of 12 m made the bulk density and large pore spaces increased. Pore-size distribution indicated that aggregate formation was accelerated by such management.

Values of bulk density is known to be reflected on those representing the total porosity.

Zeinel-Abdedine (1959) reported that the total porosity in most loamy soils is 34%. This value was 47 and 53% in lay loam and heavy clay soils respectively.

Bishai (1961) found that the average total porosity percent in the soil of Cairo University experimental Farm at Giza before ploughing ranged between 34.46 and 42.59 % in the 0-13 cm layer, and between 25.46 and 2?.67 % in the 13-25 cm. layer. After the first ploughing, the values increased to 48.26-55.66%, 28.03 - 55.17% in the 0-13, 13-25 cm layers respectively.

Miliauskas (1964) showed that in drained aerono-gley leached soils under perennial herbage, volume weight increased and porosity of the upper horizons decreased.

Nesterova (1966) mentioned that drainage by depressions and closed collectors, designed to accelerate the run-off on the soil surface and within the soil during the monsoon, improved the water air regime of the plowed top 20 cm of soil, but had practically no effect on the 20-100 cm layer which remained practically saturated with water.

Bukavestakas (1966) pointed out that in a lithuanian fen bog with a peat layer 2-3 to 8 m thick, mole drainage in addition to tile drainage or open drains improved the air-moisture, temperature and nutrient regimes of the soil.

Naumov (1969) reported that in a 3-years experiment in Karelia (U.S.S.R.), systematic drainage by drains 16 m apart during the vegetative period improved the water and air regime compared with drains 30 m apart or a net work of open drains 40 m apart.

According to several investigators such as Kelley (1951), sodium saline soils undergo certain important physiochemical changes as a result of leaching. As the soluble salts are leached out, the colloidal particles tend to be dispersed and this becomes especially marked when Na^+ ions comprise a high percentage of the total exchangeable cations. The result is that the dispersed particles are leached downward, and form a dense-sub-soil horizon.

Harris (1931) reported that the permeability decreased exponentially as sodium percentage increased.

Ayers (1951) studied the direction of ground-water flow and development of water table in soil profile under conditions of salinity in an area characterized by a gently undulating flood plain of recent alluvial deposits. He showed that the analysis of ground water theory indicated that high water table was the result of canal or irrigation effluent seepage, decreasing soil permeability and alluvial-cone formation. High salt concentrations within soil profiles, in the direction of ground-water flow, occurred where predominatly course or medium texture changed to fine ones with resulting decrease of permeability on flat and lower-lying regions.

Diseker and Van Schil Fraarde (1958) showed that drainage at ?-4 ft. depth and 150-200 ft. apart were all about equally effective. Variations in the efficiency of drainage were due to the heterogeneity of the soil (particularly in respect of hydraulic conductivity and pore size distribution) rather than to the different treatments themselves.

The development of physical impermeability in alkali soil was usually correlated with the percentage of sodium saturation or degree of alkalinization. When the sodium saturation percentage exceeded 15 percent, deterioration of the physical properties of the soil generally sets in, Jackson (1958).

Chen (1964) concluded that applying $Ca(OH)_2$ at 3.30 me./100 g soil (to pH 6.6) significantly increased the permeability but with 6.60 me./100 g soil the permeability decreased, the stability index and pore space associated with 28.4 mu pores (tension 0.1 atm.) increased and bulk density decreased. Applying NaOH had the opposite effects to $Ca(OH)_2$ whereas NaCl had the same effects as $Ca(OH)_2$ on both pore space and bulk density.

Bower, *et al.* (1965) showed that there was an interrelationship between permeability and exchangeable Na^+ percentage. Silva *et al.* (1965) also reported that slow permeability was related to high exchangeable-Na percentage.

Rogowski *et al.* (1966) carried out some drainage experiments using continuous cultivation of maize, continuous cultivation of lucerne or rotation of maize-maize oats-ley on silty clay loams. They showed that differences in rates of drainage were associated with differences in the permeability of substrate rather than with difference in treatment.

Sonbol (1967) concluded that the permeability was affected by the amount of wide-pores, size of particles, soluble salts, and exchangeable bases. Van Schalk (1967) reported that the relative decrease in permeability with increase in exchangeable Na^+ was dependent not only on the ESP and electrolyte concentration in the soil, but also was affected by the types of clay minerals. Hartge and Bailly (1967) reported that hydraulic-conductivity values varied in soils under investigation between 10^{-1} cm/sec. and 10^{-6} cm/sec. Frequency of high conductivity values decreased with soil depth. Conductivity was mainly influenced by continuous pore systems mainly occurring in the upper horizons of soils not showing impeded drainage (gleying). Gleying reduced both pore continuity and conductivity (5×10^{-5} cm./sec.).

McNeal, et al. (1968) showed that replacing the calcium in percolating NaCl and $CaCl_2$ solutions with magnesium measurably decreased soil hydraulic conductivity, although the effect was often negligible when comparisons were made at equivalent exchangeable-sodium-percentage.

The primary purpose of drainage is to remove the excess surface water and to promote a rapid downward flow of water through the soil profile so that ground-water level is not too high for plant growth, Millar, et al. (1958).