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[5] - SUMMARY

STUDIES ON SOME SALT AFFECTED SOILS IN EGYPT

The importance of this study reviewed to the large area which occupy by the salt- affected soils in Egypt. Thus, this work was carried out to study the main chemical and physical properties and the content of some macro-and micronutrients of some salt-affected soils in Egypt to evaluate these soils and also to estimate their fertility levels. The effect of the studied soil properties on plant growth and its chemical composition also was studied.

This study was carried out on three areas of salt-affected soils in Egypt, i.e. El- Fayoum (El- Fayoum Governorate), Balttim (Kafr El-Sheikh Governorate) and Edko (El-Beharia Governorate). The main limited factor to select these areas was their location beside the lakes of Qaroun, El- Borollus and Edko, respectively. Four soil profiles at the distance of 1,5, 10 and 15 km from the lake were selected of each area. The cultivated plant at each location was recorded. Disturbed and undisturbed soil samples were taken at the depth of 0-30, 30-60, 60-90 and 90 < cm of each soil profile. This work including two studies. The first one was including the laboratory studies where the second one was greenhouse experiment.

A- Laboratory studies:-

The disturbed soil samples were air-dried, ground, sieved through a 2 mm sieve and kept for laboratory analysis. The analysis which carried out on the disturbed soil samples were:- total soluble salts,

soluble cations and anions, soil pH, the content of both organic matter and calcium carbonate, cation exchange capacity and exchangeable cations.Also, the total and available contents of some macro-and micronutrients were determined . The studied soil physical properties were bulk and real densities, dry sieving, water stable aggregates and their parameters, moisture retention curves and hydraulic conductivity. **The obtained data can be summarized as follows:-**

1. Chemical properties:-

- The content of total soluble salts was ranged from 1.45 to 34.92 dSm^{-1}. The arrangement of the studied areas according to the content of total soluble salts was, El-Fayoum > Balttim > Edko. The content of total soluble salts was decreased with the increase of both soil depth and the distance from the lake. The rate of this decrease varied according to the studied area.

- The dominant soluble cations in all studied soil samples was Na^{+} followed by Mg^{2+} in most studied soil profiles and by Ca^{2+} in the others. The content of soluble K^{+} was very low. The high content of soluble cations was found in the soil samples of El-Fayoum area. The content of soluble cations was decreased with the increase of both soil depth and the distance from the lake.

- The arrangement of soluble anions according to its content in the studied soil samples was $Cl^{-} > SO_4^{2-} > HCO_3^{-}$ .This content was decreased with the increase of both soil depth and the distance from the lake. The high content of soluble anions was found in the soil samples of El-Fayoum area.

- The studied soils have a high values of SAR which decreased with the increase of soil depth and the distance from the lake. The highest values of SAR were found in the soil samples of El-Fayoum followed by those of Balttim samples.

- Sodium number values of the studied soil samples ranged between 0.55 to 2.36. The order of the studied areas according to Na-No was El-Fayoum > Balttim > Edko. In most studied soil profiles Na-No values were decreased with the increase of soil depth and the distance from the lake. The studied soils were classified based on Na-No.

- The values of soil pH were ranged between 7.8 to 8.8 where the highest values were found in the soils of Edko followed by those of El-Fayoum. The values of pH were increased with the increase of soil depth, while its relation with the distance from the lake was unclear.

- The studied soils content of OM was ranged from 0.61 to 2.89 % where this content was decreased with the increase of soil depth. According to this content, the studied areas take the following order:- Edko > Balttim > El-Fayoum. No clear effect of the distance from the lake on the soil content of O.M was noticed.

- The studied soils content of $CaCO_3$was ranged from 0.50 to 3.37 %. Based on the mean values of $CaCO_3$ %, the soils of the studied areas take the following order:- El-Fayoum > Edko > Balttim. The effect of both soil depth and the distance from the lake on the content of $CaCO_3$ % was unclear.

- The values of CEC of the studied soil samples were ranged from 28.69 to 58.49 c mol/kg soil. The highest values of CEC were found in the surface layers of soil profiles. The relationship between CEC values and the distance from the lake was unclear. According to the values of CEC, the soils of the studied areas take the order: Balttim > El-Fayoum > Edko.

- The dominant exchangeable cations in the studied soil samples were Na^+ and/ or Mg^{2+} followed by Ca^{2+}. The high content of these cations was found in the surface layers where this content was not related with the distance from the lake.

- The studied soil samples have a wide variation in their ESP values, where they ranged from 23.51 to 43.46 %. This cleared that all the studied soils were sodic soils. These values were not related with either soil depth or the distance from the lake. The soils of the studied areas take the order of : El-Fayoum > Edko > Balttim according to their ESP values. The EMgP for the studied soil was high and ranged between 24.86 to 35.70 % .

2- Nutrients status:-

* Macronutrients:-

- The soil content of total available N was ranged from 4.00 to 14.00 mg/kg soil. The soils of the studied areas were arranged according to the content of total available N as follows: El-Fayoum > Edko > Balttim. The soil content of NH_4^+ - N was higher than that of NO_3^- - N. The content of total available N (NH_4^+ - N + NO_3^- - N) was decreased with the increase of soil depth, where the relationship between this content and the distance from the lake was unclear.

- The content of available P in the studied soil samples was low and ranged from 0.06 to 0.68 mg/ kg soil. According to the content of available P, the soils of the studied areas take the following order:- Edko > Balttim > El-Fayoum. The content of available P was decreased with the increase of soil depth where this content was not related with the distance from the lake.

- The content of available K in the studied soil samples was higher than that of the other macronutrients, where this content was ranged from 447.33 to 1292.46 mg/kg soil. Based on this content, the soils of the studied areas take the following order: Balttim > Edko > El-Fayoum. The content of available K was decreased with the increase of soil depth and the distance from the lake.

*** Micronutrients:-**

- The content of total and available Fe was ranged from 20336.00 to 55351.00 and 1.00 to 8.00 mg/kg soil, respectively. This content in most studied soil profiles was decreased with the increase of both soil depth and the distance from the lake. The arrangement of the soils in the studied areas take the order of: Edko > Balttim > El-Fayoum and El-Fayoum > Balttim > Edko for the content of total and available Fe, respectively. The content of available Fe was represented a small percent (about 0.01 %) of the total content.

- The data of the statistical measures showed that, the high values of W of total Fe were found in the soil profiles of Edko. The arrangement of the studied profiles according to W values was 8> 12> 9> 11> 7> 5> 10> 3> 2> 6> 4> 1. The high symmetrical distribution of total Fe was found in the soil profiles of Edko followed by those of

Balttim and the relationship between T values and the distance from the lake was not clear.

- The content of total and available Mn was varied widely and ranged from 283.00 to 1215.00 and 1.80 to 19.00 mg/ kg soil, respectively. This content was decreased with the soil depth increase. According to the content of both total and available Mn, the studied soils in the three areas take the order: Edko > Balttim > El-Fayoum. The content of available Mn was represented a small percent of total content where it was ranged between 0.56 to 2.29 %.

- The high values of W of total Mn were found in the soil profiles of Edko followed by those of Balttim and these values were not related with either soil depth or the distance from the lake. The symmetrical distribution of total Mn varied from profile to another, where the high symmetrical distribution was found in the soil profiles of Edko area.

- The content of total and available Zn was varied widely and ranged from 75.00 to 293.00 and 2.40 to 11.40 mg/ kg soil, respectively, where the soils of the studied areas take the order: Balttim > El-Fayoum > Edko and Edko > Balttim > El-Fayoum for total and available Zn, respectively. This content was decreased with the increase of both soil depth and the distance from the lake.

- The high values of W of total Zn were found in the soil profiles of Edko followed by those of Balttim soil profiles. The calculated values of T showed a wide variations in the symmetrical distribution of total Zn in the studied soil profiles.

- The studied soils content of total and available Cu was ranged from 34.00 to139.00 and 0.20 to 3.70 mg/ kg soil, respectively. This content was decreased with the increase of soil depth and unclear related with the distance from the lake. The arrangement of the soils in the studied areas was : Balttim > Edko > El-Fayoum and El-Fayoum > Edko > Balttim, based on the content of total and available Cu, respectively. The content of available Cu represent a small percent of the total content (0.27 to 5.00 %).

- The high values of weighed mean of total Cu were found in the surface layers especially in the soil profiles of Balttim. The high symmetrical distribution of total Cu was found in the soil profiles of Balttim followed by that of Edko soil profiles. This symmetrical distribution was not related with the distance from the lakes.

The calculated values of specific range (R) of the total content of all micronutrients under study revealed that, the studied soils were composed from homogenous materials.

*** The statistical measures for total soluble salts and soluble Na^+ :**

- The high values of weighed mean of both total soluble salts and soluble Na^+ were found in the surface layers of the studied soil profiles and these values were decreased with the increase of the distance from the lakes. The calculated T values for the soils of the studied areas take the following order: El- Fayoum > Edko > Balttim.

- There are a symmetrical distributions as suggested from values of both total soluble salts and soluble Na^+, where the symmetrical degree for total soluble salts was higher than that found for soluble Na^+. The soils of the studied areas take the order: El-Fayoum > Edko

> Balttim according to the degree of symmetrical distribution of total soluble salts and soluble Na^+.

- The calculated values of specific range (R) showed that, the salt affected soils of El- Fayoum, Balttim and Edko were composed and formed from homogenous materials.

- The tested statistical measures (W, T and R) of total soluble salts and soluble Na^+ can be considered as statistical measures as well as it is used for trace elements.

3- Physical properties:-

- The studied soil samples have a clay texture. The contents of coarse sand, fine sand, silt and clay were ranged from 0.00 to 10.68, 2.77 to 22.69, 15.43 to 39.48 and 41.16 to 72.73 %, respectively.

- The content of coarse sand, fine sand and silt on the studied soil profiles was slightly decreased with the increase of soil depth. The content of fine fraction (silt+ clay) was slightly increased with the distance increase from the lakes. Also, the high content of clay was found in the soil samples of Balttim area.

- The values of soil bulk density of the studied soil samples were ranged from 1.09 to 1.39 gm/cm^3. These values were frequently increased with the increase of both the distance from the lake and the soil depth.

- The values of soil real density ranged between 2.17and 2.50 gm/ cm^3. These values were very slightly affected by soil depth and the distance from the lake.

- The values of soil total porosity of different soils under study were ranged between 39.65 and 56.40 %. These values were decreased with the increase of both soil depth and the distance from

the lake. The high values of soil total porosity were found in the soil samples of El-Fayoum area.

- The values of pore size distribution as percent from the total volume of the soil were ranged from 0.19 – 6.76, 1.28 – 6.97, 2.84 – 13.01, 7.08- 21.62 and 20.62 – 31.71 % for the pore classes > 28.80, 28.80-8.62, > 8.62, 8.62-0.19 and < 0.19 μ respectively. These percentages were affected by soil depth and the distance from the lakes.

- The values of soil hydraulic conductivity (K) were ranged from 0.002 to 0.047 cm/min. These values were decreased with the increase of soil depth, while no clear effect could be noticed for the distance from the lakes on these values.

- In all studied soil samples, the percentage of dry aggregates having diameter between 10.00 –1.00 and 1.00 - 0.50 mm were higher than any other aggregates, while the lowest value was found for the aggregates having diameter of < 0.063 mm. The high values of D.S.S % were found in the soil samples of deeper layers. No clear trend could be detected between the values of D.S.S % and the distance from the lakes.

- The values of mean weight diameter (M.W.D) of dry stable aggregates are highly affected by soil sampling depth and increased with the increase of soil depth and there are no clear trend between these values and the distance from the lakes.

- The values of W.S.S % (wet sieving stable aggregates) were ranged between 7.70 and 68.10 %. The aggregates having diameter between 10.00 –1.00 and 1.00- 0.50 mm were higher than other

aggregates fractions under study. No clear trend can be noticed between W.S.S % and both the distance from the lakes and sampling depth.

- The values of M.W.D of water stable aggregates are very low as compared with these of dry stable aggregates for all studied soil samples.

- The values of M.W.D for W. S.S were decreased with the soil depth increase where no clear trend was found between M.W.D and the distance from the lakes.

- The values of Δ M.W.D of D.S.S and W.S.S ranged between 1.97 and 5.09 and relatively increased with increasing soil depth, and no clear effect of the distance from the lakes on these values was noticed.

- The values of aggregation state (A.S) ranged between 7.70 and 68.10. These values were relatively increased with soil depth increase where these values were not related with the distance from the lakes. The high values of A.S were found in the soil samples of Edko area followed by those of Balttim area.

- The values of aggregation degree (A.D) ranged between 25.09 and 99.25 and the effect of both soil depth and the distance from the lakes was not clear. The high values of A.D were found in the soil samples of Edko area followed by those of Balttim area.

- The values of aggregation index (AI) were small and ranged from 0.07 and 0.94. The values of AI were decreased with the increase of soil depth, while these values were not affected by the distance from the lakes. The high values of AI were found in the soil samples of Edko area followed by those in the soil samples of Balttim area.

- Soil moisture contents were decreased by increasing the applied pressures and this function is mainly affected by particles size distribution which affected on the characteristics of moisture tension curves. No clear trend was observed for the effect of the distance from the lakes on the moisture retention curve characteristics.

- The moisture content of the studied soil samples at field capacity was ranged between 31.33 and 44.58 %. These values were not clear related with sampling depth, but were gradually decreased with the distance increase from the lakes and slightly affected by the studied area (salinity source). The highest values of field capacity were found in the soil samples of El- Fayoum area.

- The moisture content of the studied soil samples at wilting point was ranged between 20.62 and 31.71 %. This content was not affected by the distance from the lakes, while it was increased with the increase of soil depth. The high moisture content at wilting point was found in the soil samples of El-Fayoum area followed by that found in the soil samples of Edko area.

- The content of available water was low and ranged between 7.08 and 21.62 % (average value 9.09 – 16.93 %). This content was decreased with the increase of both soil depth and the distance from the lakes. The high content of available water was found in the soil samples of Balttim area followed by that found in the soil samples of El-Fayoum area.

B- The greenhouse experiment:-

- This study was carried out on samples of the surface layers of the studied soil profiles (12 samples). Barley plant was used as a test

plant where barley seeds were planted in a plastic pots in three replicates. The pots were treated according to the recommendations of Agricultural Ministry. The plants were harvested after 45 days from planting. The harvested plants were air-dried, weighed and analyzed for its content of N, P, K, Na, Fe, Mn, Zn and Cu. The main results of this experiment were:-

- The obtained fresh and dry matter yield (g/pot) of barley plants were decreased with the increase of soil salinity and increased with the increase of the distance from the lake. According to the yield of barley plants, the studied areas take the order: Balttim > Edko > El- Fayoum.

- The concentration (%) and uptake (mg/ pot) of N, P and K by barley plants were decreased with the increase of soil salinity and increased with the increase of the distance from the lakes.

- The arrangement of the studied areas according to the content of N and P was Balttim > Edko > El- Fayoum and it was Balttim > El- Fayoum > Edko for the content of K. On the other hand, this order for Na content was El- Fayoum > Balttim > Edko. The content of Na^+ was related positively with the soil content of total soluble salts.

- The content of the studied micronutrients of barley plants takes the order: Fe > Mn > Zn > Cu. This content was related positively with the distance from the lakes and the soil content of available micronutrients and related negatively with the soil content of total soluble salts. According to plant content of micronutrients, the studied areas take the order: Edko > Balttim > El- Fayoum.

[6] - CONCLUSON

The soils in the three studied areas i .e. El-Fayoum, Balttim and Edko were salt affected soils and characterized by bad chemical and physical properties and low content of available macro and micronutrients. Thus, from the obtained data and its discussion we can be concluded that, the common reclamation processes applied for these soils must be include :-

1- Improvement of soil physical and chemical properties through deep ploughing and addition of different amendments such as organic matter and gypsum which in the most commonly chemical amendment used in Egypt due its low cost and its smoothly application .

2- Replacement of exchangeable Na^{+} and Mg^{2+} on exchangeable complex by Ca^{2+} and removal of the products of the process through leaching and drainage.

3- Use of suitable qualities and requirements of irrigation water in the presence of suitable drainage system.

4- Leaching the excess of soluble salts through continuous or uncontinuous leaching processes using suitable sources of water.

5- Application different plant nutrients (macro and micro) in different forms and by different application methods.

6- The application fertilizers must be more than plant requirements.

7- The applied drainage system must be design through a good system.

8- Applied agricultural rotation must be more suitable where it's including legume plants.

9- The selected plants to cultivation in these soils must be characterized by high tolerance for soil salinity and alkalinity.

10- The continuous farming for these soils.

11- The cost of reclamation and farming of these soils must be low. Also the farming requirements must be sufficient.