# IMPACT OF SALINITY LEVELS AND EFFECTIVE SOIL DEPTH ON SORGHUM PLANTS GROWN IN SOME NILE ALLUVIAL AND CALCAREOUS SOILS UNDER EL FAYOUM CONDITIONS

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**ABSTRACT:**

This work aims to evaluate the effect of both salinity levels (normal ECe < 4, moderate 4-8 and saline 8-16 dS/m) and soil effective depths (shallow ≈ 55 cm, medium ≈ 80cm and deep ≈ 120cm water table depths) on sorghum productivity (Giza 15) grown during two successive seasons (2002 and 2003) on a Nile alluvial soil and calcareous one under El Fayoum Governorate conditions.

The obtained results revealed that the tested soil salinity levels and effective soil depths greatly affected some soil properties, i.e., soil bulk density, total porosity, void ratio, air porosity, pore size distribution, water retention and transmission in the studied two soil sites during the two successive seasons. In addition, increasing soil salinity levels caused significant decreases in the studied plant growth parameters, yield and its components, i.e., plant height, panicle length, weight of 1000 grains, protein content % and grain yield, which reached 36.98, 32.27, 20.45, 29.95 and 57.46% at the Nile alluvial soil vs 36.76, 33.31, 24.05, 33.75 and 59.14% at the calcareous one, respectively, when soil salinity levels increased from $S_1$ (normal soil) to $S_3$ (saline soil).

Also, decreasing the studied effective soil depths led to deteriorate all the aforementioned soil properties and grown plant parameters, where reducing effective soil depths from deep to shallow water table led to decrease plant height, panicle length, weight of 1000 grain, grain protein content and yield by 32.48, 24.13, 11.64, 11.78, and 86.55% in the Nile alluvial soil vs 34.2, 18.19, 11.97, 16.51 and 86.18% in the calcareous soil, respectively. The negative interaction effect between soil salinity levels or effective soil depth and plant parameters in the studied soils were clearly defined. So, it should maintain soil salinity at low level and effective soil depth at deep water table depth for producing high sorghum grain yield with satisfactory quality.

**Key words:** Effective soil depth, soil salinity, water table depth, growth and quality of sorghum.

## INTRODUCTION:

Extensive area of land in the world, particularly in Egypt as an arid region, have gone out of cultivation due to accumulation and build up of salts, ground water table rises or its fluctuations, poor water management, inadequate drainage and adverse soil characteristics or climatic conditions. Such factors are considered to be effective factors causing and confirming soil salinization and consequently accumulation of salts in soils, which lead to unfavorable soil water-air-plant relationships, then decrease crop productivity. In Egypt, total area of salt- affected soils reaches 2.21 million feddans, and represents 33 % of the agricultural area **(Ghassemi *et al.*, 1995).** As for El Fayoum area, **Abd El-Motaleb (1997)** stated that soils were suffering from salinization (ECe > 8.0 dS/m) reaches 80812.5 fed in 1982, then increased to 115158.9 fed at 1995, and mostly are located surrounding Qarun Lake at both districts of Sannuris and Abshway.

**Ali *et al*. (2000)** found that the values of bulk density increased, as well as, total porosity and void ratio decreased when the ground water depth to be shallow. Also, they added that the shallow water table depths or fluctuated water levels and /or developed in arid or semi arid environments may have appreciable quantities of exchangeable sodium ions that balancing the lattice of charged clay minerals and this may impart adversely effects on some soil physical and chemical properties. The macro pores that are better conductors of water go out of action with an increase of suction. The water has now to move through micro pores, which offer considerable resistance to its passage and consequently reduce its conductivity and water table levels, **(Olesen *et al.,* 1997)**.

**Navada *et al*. (1993)** reported that experimental results have confirmed that the hydraulic conductivity behaviour was more related to $Na^+/Ca^{++}$ ratio, where lower hydraulic conductivity was occurred in dilute solutions of high $Na^+/Ca^{++}$ ratio **(El-Samnoudi and Abou- Arab (2000a). Ibrahim *at al*. (2003)** found that the increases in soil salinity (ECe) and exchangeable sodium percentage (ESP) of the soil caused significant decreases of both saturated hydraulic conductivity (Ksat) and unsaturated hydraulic conductivity. Also, they reported that the Ksat and Kθ values were significantly increased with increasing water table depth.

Grain sorghum (*sorghum bicolor* L.) ranks as the worlds fourth most important cereal crop. Three hundred million people are dependent upon it as a cereal grain in the world, as it is generally adapted to producing high yields under less favourable ecological conditions than required for corn**.** Also, it is one of the most important cereal crops in Southern and Upper Egypt, where its area reached 150000 ha; production 800000 tons **(FAO, 1991)**.

The current study aims to evaluate the effect of soil salinity levels and effective soil depth on some soil properties of the Nile alluvial and calcareous soils as well as their productivity for sorghum under El Fayoum Governorate conditions.

## MATERIALS AND METHODS:

### *a. Field experiments:*

Two field experiments were conducted at two different soil sites. i.e., Menshiat Tantawy, Sannuris district (Nile alluvial soil, profiles Nos. 1-9) and Demo, El Fayoum district (calcareous soil, profiles Nos. 10-18). Each soil site is characterized by three effective soil depths (shallow W1 ≈55 cm, medium W2≈ 80 cm and deep W3≈ 120 cm water table depths). Measurements of water table depths (WTD, cm) were conducted using the observation wells by means of graduated tape during the growth season **(Morrison, 1983)**. Also, each area of effective soil depths included three levels of soil salinity (ECe S1 <4.0, S2 4-8 and S3 8–16 dS/m). Thirty six pizometers were established on almost straight transects in each site for measuring the fluctuations periodically of the ground water depth all over the year.

The used design for the current field experiments was a complete randomized block, with four replicates and an area of 10.5 $m^2$ (3.0 m width x 3.5m length) for each plot. The distance between rows was 60 cm. The studied plots were planted with sorghum (*Sorghum vulgaris L.***,** Giza 15) during the two summer seasons of 2002 and 2003, using the recommended management practices that typical as be used in each soil site. Sorghum seeds were planted manually in hills 20 cm apart from each other the 20th and 25th May for 1st and 2nd seasons, respectively. At harvest (120 days from planting), sorghum plants were subjected to determine grain yield and quality for each season.

Also, the grown plants in each site were received the different mineral fertilizers, i.e., 150 kg/fed of superphosphate (15.5% $P_2O_5$) added prior to cultivation, 250 kg/fed ammonium nitrate (33.3%N) added in two equal doses at the first and second irrigation dates, and potassium sulfate (48 % $K_2O$), at the rate of 50 kg/fed.

***b. Methods and measurements:***

**** Soil analysis:***

Disturbed and undisturbed soil samples were collected before planting and at harvest of sorghum according to the effective soil depth, i.e., at 0-20 and 20-40 cm in soil profiles 1, 4, 7, 10, 13 and 16 and at 0-20, 20-40 and 40-60 cm in other soil profiles to determine some physical and chemical properties of the studied soils.

- Particle size distribution, soil particle density, bulk density, total porosity, void ratio, air porosity, structure factor, pore size distribution and the hydraulic conductivity have been conducted according to the methods described by **Klute (1986).**
- Soil pH, ECe**,** soluble cations, soluble anions, CEC, exchangeable cations, ESP, calcium carbonate contents and organic matter content were determined using the techniques described by **Page *et al*. (1982)**.

**** Plant parameters:***

- Plant height in cm was measured from the catolydonary at the head (panicle), dry 1000 grain weight in g, length of panicle in cm, dry grain yield/fed in ardab that determined from the seed yield/plot of each treatment and grains protein content % which was determined by estimating the total nitrogen percentage calorimetrically by using the Orange dye method, according to method described by **Hafez and Hikkelsen (1981)**.
- The least significant difference (L.S.D.) was used to compare between the averages **(Snedecor and Cochran, 1980)**.

## RESULTS AND DISCUSSIONS:

***I. <u>Soil properties as affected by soil salinity levels and effective soil depths:</u>***

The physical and chemical characteristics of the two experimental soils are shown in Tables (1 and 2). The data reveal that both Nile alluvial and calcareous soils are characterized by light to medium texture grades (sandy to sandy clay loam), as well as, different soil salinity levels. Both increase or decrease in any soil variable as a percentage for a normal soil could be calculated from the mean values of two successive seasons.

***a) Soil bulk density:***

As clearly shown in Table (3), values of soil bulk density of both the two studied soils ranged from 1.51 to 1.68 g/cm$^3$, and have been increased with depth increments due to the reduction in volume occupied by a soil mass. It was also noticed that increasing soil salinity levels resulted in increasing the values of soil bulk density because of their pronounced hydrations and unfavourable soil structure. Such findings fall in line with those of **Jury *et al*. (1991) and El-Samnoudi and Abou Arab (2000a)**.

***b) Total porosity, void ratio and pore size distribution:***

The obtained values of total porosity (Table, 3) tended to decrease with depth increments. Also, increasing salt content of the studied soils resulted in decreasing the values of total porosity in the Nile alluvial soil by 2.79-13.93, 1.96-10.39 and 0.40-7.81% vs 6.38-9.66, 5.00-8.34 and 6.89-9.32 % in the calcareous soil at shallow, medium and deep water table depths, respectively, when soil salinity levels increased from S1 to S2 and S3 levels, respectively.

As a general trend, data in Table (3) indicate that the void ratio, which represents the pore volumes: the soil solid volumes, showed a reduction existed in its values for both the two studied soils with depth increments. Increasing salt content of the studied soils resulted in decreasing the void ratio values in the Nile alluvial soil by 1.61-6.45, 2.99-10.45 and 1.47-10.29% vs 3.03-7058, 5.88-8.82 and 2.78-8.33% in the calcareous one at shallow, medium and deep water table depths, when soil salinity levels increased from S1 to S2 and S3 levels, respectively.

***c) Air porosity and soil structure factor:***

Air porosity values, as calculated by difference between soil total porosity and the volumetric water contents, are shown in Table (3). The obtained data show that air porosity tended to decrease with increasing soil depth as well as considerable decreasing with increasing soil salinity in both the studied soil sites. Increasing the soil salinity levels decreased the values of the air porosity by 5.96-10.99, 9.86-9.95 and 6.12-10.08 % in the Nile alluvial soil vs 9.08-30.09, 14.92-17.89 and 9.71-5.72 % in the calcareous one at shallow, medium and deep water table depths when soil salinity levels increased from $S_1$ to $S_2$ and S, respectively.

This behavior can be attributed to false aggregates formation when soil salinity increased in the Nile alluvial soil (profiles Nos. 1-9). Also, this behaviour can be confirmed by increasing soil bulk density, which affects gaseous diffusion as both reduce air porosities and diffusion. In addition, soil salinity levels affects aggregates formation and both of aggregation index and structure factor, which indirectly affect the gaseous and air- permeability and hence restrict air filled pores.

Also, increasing soil salinity levels resulted in decreasing the values of soil structure factor by 3.88-15.53, 0.14-23.97 and 1.98-24.42% in the Nile alluvial soil vs 10.30-24.63, 11.17-23.66 and 7.85 and 10.91% in the calcareous one at shallow, medium and deep water table depths when soil salinity levels increased from S1 to S2 and S3, respectively. These findings may be attributed to soil salinity levels, which affect the aggregates formation and aggregation index, particularly when increasing both soluble Na-salts and exchangeable sodium. Also the values of soil structure factor increased with increasing water table depth due to the improvement of soil aeration and biological activity. Such findings are in agreement with those reported by **Jury *et al*. (1991)**.

***d) Water movement:***

The values of Ksat in the Nile alluvial soil decreased with increasing soil salinity by 14.95-38.79, 14.79-38.51 and 15.86-25.34% in the Nile alluvial soil vs 15.66-28.3, 16.27-22.05 and 13.60-27.68% in the calcareous one at shallow, medium and deep water table depths when soil salinity levels increased from S1 to S2 and S3, respectively, Tables (2 and 3). This may be due to the increase of soil salinity prevent free swelling of colloids by reducing the quality of cation and anion concentrations at their medial plane, as well as, the osmotic and hydrostatic pressure differences. By the presentation of free swelling, the soil pores remain open and the hydraulic conductivity values are improved. The values of saturated hydraulic conductivity increased with increasing water table depth in both the Nile alluvial loamy sand and calcareous soils due to the improvement of soil structure in the case of deep water table depth than those of high water table depth. In light textured soils as the calcareous one the obtained trends fall in line with those of **Navada *et al.* (1993) and El-Samnoudi and Abou-Arab (2000a)**.

**Table (1): Particle size distribution in the studied soils.**

| Soil Salinity (dS/m) | Profile No. | Depth (cm) | Particle size distribution % | | | | Texture class |
|---|---|---|---|---|---|---|---|
| | | | C. sand | F. sand | Silt | Clay | |
| *The Nile alluvial soil* | | | | | | | |
| $S_1$ (0-4) | 1* | 0-20 | 34.65 | 44.60 | 10.00 | 10.75 | loamy sand |
| | | 20-40 | 35.48 | 43.75 | 10.10 | 10.67 | loamy sand |
| | 2** | 0-20 | 28.93 | 48.61 | 11.30 | 11.16 | sandy loam |
| | | 20-40 | 25.40 | 43.70 | 13.50 | 17.40 | sandy loam |
| | | 40-60 | 23.91 | 48.38 | 15.81 | 11.90 | sandy loam |
| | 3** | 0-20 | 46.13 | 35.01 | 7.96 | 10.90 | loamy sand |
| | | 20-40 | 35.95 | 35.05 | 18.10 | 10.90 | sandy loam |
| | | 40-60 | 36.75 | 42.10 | 13.21 | 7.94 | loamy sand |
| $S_2$ (4-8) | 4* | 0-20 | 20.84 | 58.25 | 11.06 | 9.85 | loamy sand |
| | | 20-40 | 19.81 | 58.39 | 12.30 | 9.50 | sandy loam |
| | 5** | 0-20 | 32.30 | 43.30 | 13.10 | 11.30 | sandy loam |
| | | 20-40 | 25.13 | 50.50 | 11.94 | 12.43 | sandy loam |
| | | 40-60 | 29.70 | 45.03 | 12.60 | 12.67 | sandy loam |
| | 6*** | 0-20 | 37.42 | 40.11 | 10.10 | 12.37 | loamy sand |
| | | 20-40 | 40.13 | 38.14 | 9.80 | 11.93 | loamy sand |
| | | 40-60 | 37.14 | 40.61 | 11.70 | 10.55 | loamy sand |
| $S_3$ (8-16) | 7* | 0-20 | 29.70 | 48.83 | 9.12 | 12.35 | loamy sand |
| | | 20-40 | 27.48 | 50.31 | 8.39 | 13.82 | loamy sand |
| | 8** | 0-20 | 40.31 | 37.83 | 9.21 | 12.65 | loamy sand |
| | | 20-40 | 40.13 | 37.30 | 8.96 | 13.61 | loamy sand |
| | | 40-60 | 43.85 | 32.14 | 9.05 | 14.96 | loamy sand |
| | 9*** | 0-20 | 58.78 | 22.48 | 8.29 | 10.45 | loamy sand |
| | | 20-40 | 41.21 | 32.18 | 13.10 | 13.51 | sandy loam sandy |
| | | 40-60 | 34.22 | 40.15 | 12.10 | 13.53 | loam |
| *Calcareous soil* | | | | | | | |
| $S_1$ (0-4) | 10* | 0-20 | 66.68 | 16.37 | 5.63 | 11.32 | loamy sand |
| | | 20-40 | 65.99 | 17.42 | 3.69 | 12.90 | loamy sand |
| | 11** | 0-20 | 35.35 | 40.77 | 8.08 | 15.80 | sandy loam |
| | | 20-40 | 46.66 | 31.50 | 4.37 | 17.47 | sandy loam |
| | | 40-60 | 63.90 | 17.82 | 5.49 | 12.79 | sandy loam |
| | 12*** | 0-20 | 40.53 | 33.53 | 9.34 | 16.60 | sandy loam |
| | | 20-40 | 51.34 | 19.88 | 11.10 | 17.68 | sandy loam |
| | | 40-60 | 54.00 | 25.06 | 6.27 | 14.67 | sandy loam |
| $S_2$ (4-8) | 13* | 0-20 | 62.74 | 16.84 | 5.81 | 14.61 | sandy loam |
| | | 20-40 | 68.44 | 13.90 | 3.54 | 14.12 | sandy loam |
| | 14** | 0-20 | 46.99 | 31.90 | 6.70 | 14.41 | sandy loam |
| | | 20-40 | 33.08 | 48.73 | 9.10 | 9.09 | loamy sand |
| | | 40-60 | 34.16 | 32.20 | 13.44 | 20.20 | sandy clay loam |
| | 15*** | 0-20 | 57.91 | 16.49 | 8.54 | 17.06 | sandy loam |
| | | 20-40 | 64.03 | 24.43 | 3.53 | 8.01 | loamy sand |
| | | 40-60 | 81.31 | 5.58 | 5.62 | 7.49 | loamy sand |
| $S_3$ (8-16) | 16* | 0-20 | 60.54 | 24.88 | 8.34 | 6.24 | loamy sand |
| | | 20-40 | 69.75 | 14.76 | 9.68 | 5.81 | loamy sand |
| | 17** | 0-20 | 52.01 | 37.22 | 3.00 | 7.77 | sand |
| | | 20-40 | 45.98 | 31.93 | 12.04 | 10.05 | sandy loam |
| | | 40-60 | 50.88 | 31.30 | 7.14 | 10.68 | sandy loam |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 18*** | 0-20 | 41.55 | 26.01 | 7.21 | 25.23 | sandy clay loam |
| | | 20-40 | 55.09 | 23.57 | 7.81 | 13.53 | loamy sand |
| | | 40-60 | 40.93 | 50.28 | 1.93 | 6.86 | Sand |

*Profiles of shallow water table depth ($W_1$), ** medium depth ($W_2$) and *** deep depth ($W_3$)

## Table (2): Chemical characteristics of the studied soils.

| Profile No. | Depth (cm) | PH (1:2.5) | ECe (dS/m) | Soluble cations ( meq./L) | | | | Soluble anions ( meq./L) | | | | $CaCO_3$ % | O.M % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | $CO_3^{--}$ | $HCO_3^{-}$ | $Cl^{-}$ | $SO_4^{--}$ | | |
| *The Nile alluvial soil* | | | | | | | | | | | | | |
| 1* | 0-20 | 7.95 | 3.70 | 12.00 | 8.50 | 16.32 | 0.75 | 00.0 | 2.25 | 20.59 | 14.73 | 5.03 | 1.30 |
| | 20-40 | 7.98 | 3.34 | 7.50 | 3.40 | 22.74 | 0.73 | 00.0 | 1.63 | 18.69 | 14.05 | 5.13 | 0.71 |
| 2** | 0-20 | 7.67 | 3.61 | 6.31 | 8.69 | 21.52 | 1.19 | 00.0 | 3.85 | 17.50 | 15.36 | 4.01 | 1.27 |
| | 20-40 | 7.96 | 3.23 | 4.00 | 4.00 | 24.31 | 0.83 | 00.0 | 3.39 | 16.90 | 12.85 | 4.96 | 0.69 |
| | 40-60 | 7.84 | 3.40 | 7.04 | 5.30 | 21.80 | 0.80 | 00.0 | 3.18 | 21.25 | 10.51 | 4.20 | 0.51 |
| 3** | 0-20 | 8.13 | 2.71 | 6.00 | 2.30 | 19.03 | 0.83 | 00.0 | 4.23 | 16.75 | 6.41 | 3.98 | 1.40 |
| | 20-40 | 8.04 | 2.94 | 8.34 | 5.00 | 16.86 | 0.51 | 00.0 | 4.62 | 15.35 | 10.74 | 3.58 | 0.51 |
| | 40-60 | 8.01 | 3.18 | 6.00 | 5.00 | 20.13 | 0.51 | 00.0 | 5.39 | 16.00 | 10.25 | 3.20 | 0.45 |
| 4* | 0-20 | 7.86 | 6.43 | 12.30 | 22.16 | 29.40 | 1.20 | 00.0 | 5.78 | 38.50 | 20.78 | 3.53 | 1.08 |
| | 20-40 | 7.71 | 6.61 | 9.05 | 13.00 | 44.47 | 1.34 | 00.0 | 4.62 | 35.00 | 27.24 | 3.93 | 0.64 |
| 5** | 0-20 | 7.77 | 7.51 | 18.00 | 7.00 | 49.65 | 1.06 | 00.0 | 5.39 | 40.80 | 29.52 | 4.81 | 1.10 |
| | 20-40 | 7.65 | 6.23 | 4.00 | 12.00 | 45.51 | 1.49 | 00.0 | 4.62 | 23.75 | 34.63 | 4.71 | 0.57 |
| | 40-60 | 8.02 | 8.12 | 9.00 | 20.00 | 50.92 | 1.46 | 00.0 | 3.39 | 37.00 | 40.99 | 4.97 | 0.32 |
| 6*** | 0-20 | 7.88 | 5.98 | 12.21 | 7.40 | 40.34 | 0.88 | 00.0 | 3.93 | 43.00 | 13.90 | 3.50 | 1.23 |
| | 20-40 | 7.89 | 6.51 | 8.00 | 10.54 | 41.37 | 0.68 | 00.0 | 3.85 | 43.00 | 18.74 | 3.20 | 0.82 |
| | 40-60 | 7.94 | 7.21 | 16.00 | 12.80 | 43.44 | 1.24 | 00.0 | 3.39 | 36.30 | 33.79 | 3.30 | 0.51 |
| 7* | 0-20 | 7.66 | 13.76 | 19.50 | 18.10 | 98.61 | 2.60 | 00.0 | 4.24 | 79.03 | 54.00 | 4.17 | 1.14 |
| | 20-40 | 7.90 | 15.74 | 24.00 | 11.00 | 120.66 | 0.98 | 00.0 | 4.62 | 79.25 | 72.68 | 3.80 | 1.01 |
| 8** | 0-20 | 7.88 | 9.43 | 18.00 | 11.20 | 66.20 | 1.57 | 00.0 | 3.16 | 38.40 | 53.41 | 3.50 | 0.95 |
| | 20-40 | 7.89 | 10.78 | 20.00 | 17.00 | 70.68 | 1.41 | 00.0 | 3.39 | 42.00 | 63.70 | 3.20 | 0.52 |
| | 40-60 | 7.94 | 14.86 | 19.00 | 12.50 | 115.84 | 2.53 | 00.0 | 3.39 | 80.11 | 66.47 | 3.30 | 0.38 |
| 9*** | 0-20 | 7.89 | 13.51 | 23.00 | 17.50 | 92.77 | 2.50 | 00.0 | 1.50 | 79.16 | 55.11 | 5.74 | 1.23 |
| | 20-40 | 8.01 | 9.81 | 10.00 | 12.50 | 74.21 | 2.15 | 00.0 | 1.25 | 47.16 | 50.45 | 5.87 | 0.84 |
| | 40-60 | 7.93 | 10.20 | 10.50 | 14.50 | 75.51 | 1.91 | 00.0 | 1.25 | 62.72 | 38.45 | 4.66 | 0.32 |
| *Calcareous soil* | | | | | | | | | | | | | |
| 10* | 0-20 | 7.92 | 2.11 | 9.00 | 7.00 | 5.15 | 0.43 | 00.0 | 3.51 | 10.68 | 7.39 | 14.40 | 1.10 |
| | 20-40 | 7.83 | 1.51 | 9.00 | 3.00 | 3.15 | 0.39 | 00.0 | 2.22 | 8.90 | 4.42 | 12.34 | 1.03 |
| 11** | 0-20 | 7.93 | 3.72 | 11.50 | 8.50 | 17.42 | 0.59 | 00.0 | 2.50 | 17.46 | 18.05 | 13.70 | 0.71 |
| | 20-40 | 7.95 | 2.89 | 11.11 | 9.10 | 8.40 | 1.03 | 00.0 | 3.25 | 14.35 | 12.04 | 8.64 | 0.65 |
| | 40-60 | 7.89 | 4.11 | 16.00 | 4.00 | 21.46 | 1.08 | 00.0 | 3.78 | 18.35 | 20.41 | 13.84 | 0.45 |
| 12*** | 0-20 | 7.91 | 4.17 | 12.00 | 14.00 | 13.63 | 0.59 | 0.00 | 3.88 | 19.80 | 16.54 | 10.61 | 0.81 |
| | 20-40 | 7.91 | 3.28 | 9..50 | 8.53 | 14.78 | 0.67 | 00.0 | 3.88 | 14.52 | 15.08 | 12.21 | 0.76 |
| | 40-60 | 7.95 | 3.40 | 10.80 | 6.29 | 16.35 | 0.83 | 00.0 | 4.63 | 15.10 | 14.54 | 12.81 | 0.68 |
| 13* | 0-20 | 7.72 | 6.56 | 30.00 | 11.00 | 25.46 | 0.46 | 0.00 | 4.38 | 35.81 | 26.73 | 11.10 | 1.10 |
| | 20-40 | 7.82 | 6.31 | 16.00 | 13.00 | 33.15 | 0.23 | 00.0 | 4.38 | 28.01 | 29.99 | 16.64 | 0.78 |
| 14** | 0-20 | 8.15 | 7.80 | 19.00 | 22.00 | 35.66 | 1.96 | 00.0 | 3.75 | 35.42 | 39.45 | 17.69 | 1.23 |
| | 20-40 | 8.09 | 7.63 | 19.00 | 21.50 | 35.66 | 1.01 | 00.0 | 4.75 | 36.00 | 36.42 | 21.72 | 0.78 |
| | 40-60 | 8.10 | 7.85 | 17.01 | 13.50 | 47.24 | 0.90 | 00.0 | 4.75 | 43.23 | 30.67 | 22.03 | 0.65 |
| 15*** | 0-20 | 7.85 | 6.54 | 19.00 | 18.00 | 28.35 | 0.88 | 00.0 | 4.78 | 39.78 | 21.67 | 10.49 | 1.29 |
| | 20-40 | 7.95 | 7.60 | 14.50 | 15.50 | 46.64 | 0.65 | 00.0 | 5.63 | 34.35 | 37.31 | 18.51 | 1.28 |
| | 40-60 | 7.96 | 8.55 | 9.00 | 16.00 | 59.33 | 0.78 | 00.0 | 4.50 | 47.37 | 33.24 | 10.61 | 0.65 |
| 16* | 0-20 | 8.10 | 14.78 | 21.00 | 12.50 | 112.46 | 1.73 | 00.0 | 4.75 | 84.57 | 58.37 | 15.92 | 1.81 |
| | 20-40 | 7.98 | 14.75 | 26.03 | 11.50 | 108.45 | 1.78 | 00.0 | 5.63 | 86.01 | 56.12 | 11.42 | 1.03 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17** | 0-20 | 7.89 | 10.94 | 17.00 | 16.00 | 75.93 | 1.03 | 00.0 | 3.50 | 64.24 | 42.22 | 14.36 | 1.29 |
| | 20-40 | 8.02 | 12.51 | 19.00 | 20.00 | 85.34 | 1.16 | 00.0 | 3.25 | 75.02 | 47.23 | 15.81 | 1.10 |
| | 40-60 | 8.21 | 12.60 | 30.00 | 18.50 | 77.76 | 1.03 | 00.0 | 5.75 | 82.93 | 38.61 | 13.10 | 0.13 |
| 18*** | 0-20 | 7.83 | 10.53 | 16.00 | 28.00 | 60.95 | 1.01 | 00.0 | 3.00 | 61.72 | 41.24 | 9.42 | 0.65 |
| | 20-40 | 7.97 | 10.21 | 17.50 | 16.00 | 69.12 | 1.01 | 00.0 | 3.75 | 40.69 | 59.19 | 10.91 | 0.52 |
| | 40-60 | 8.22 | 9.84 | 16.00 | 16.00 | 66.03 | 0.96 | 00.0 | 4.63 | 52.91 | 41.45 | 18.10 | 0.26 |

*Profiles of shallow water table depth ($W_1$), ** medium depth ($W_2$) and *** deep depth ($W_3$)

## Table (3): Some soil physical properties of the studied soils.

| Soil salinity, (dS/m) | Profile No. | Depth (cm) | Bulk density (g/cm³) | Particle density (g/cm³) | Void ratio | Total porosity % | | Air porosity % | Structure factor % | Ksat (cm/hr) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Deter-mined | Calcu-lated | | | |
| *The Nile alluvial soil* | | | | | | | | | | |
| $S_1$ (0-4) | 1* | 0-20 | 1.62 | 2.63 | 0.62 | 37.53 | 38.4 | 27.89 | 30.89 | 5.33 |
| | | 20-40 | 1.63 | 2064 | 0.62 | 36.94 | 38.26 | 26.21 | 29.21 | 3.22 |
| | 2** | 0-20 | 1.57 | 2.63 | 0.68 | 39.03 | 40.30 | 23.82 | 31.00 | 5.97 |
| | | 20-40 | 1.59 | 2.64 | 0.66 | 37.28 | 39.77 | 22.53 | 30.46 | 4.80 |
| | | 40-60 | 1.59 | 2.64 | 0.66 | 37.12 | 39.77 | 21.47 | 27.00 | 3.73 |
| | 3** | 0-20 | 1.55 | 2.62 | 0.69 | 39.80 | 40.84 | 24.01 | 33.21 | 6.08 |
| | | 20-40 | 1.56 | 2.63 | 0.69 | 38.02 | 40.68 | 23.29 | 30.31 | 5.49 |
| | | 40-60 | 1.58 | 2.63 | 0.66 | 35.48 | 39.92 | 22.35 | 29.00 | 3.93 |
| $S_2$ (4-8) | 4* | 0-20 | 1.65 | 2.65 | 0.61 | 36.30 | 37.73 | 21.46 | 25.89 | 4.14 |
| | | 20-40 | 1.66 | 2.66 | 0.60 | 36.12 | 37.59 | 19.27 | 24.00 | 3.13 |
| | 5** | 0-20 | 1.59 | 2.64 | 0.66 | 37.35 | 39.73 | 21.13 | 30.75 | 5.11 |
| | | 20-40 | 1.60 | 2.65 | 0.66 | 37.23 | 39.62 | 20.74 | 29.59 | 4.07 |
| | | 40-60 | 1.63 | 2.65 | 0.63 | 36.40 | 38.49 | 19.29 | 28.00 | 3.20 |
| | 6*** | 0-20 | 1.55 | 2.64 | 0.70 | 38.50 | 41.29 | 22.61 | 32.69 | 5.40 |
| | | 20-40 | 1.60 | 2.66 | 0.66 | 38.70 | 39.85 | 21.86 | 30.01 | 4.11 |
| | | 40-60 | 1.61 | 2.67 | 0.66 | 36.30 | 39.70 | 20.94 | 28.00 | 3.55 |
| $S_3$ ( 8–16) | 7* | 0-20 | 1.67 | 2.64 | 0.58 | 33.03 | 36.74 | 20.28 | 23.61 | 3.15 |
| | | 20-40 | 1.68 | 2.65 | 0.58 | 31.04 | 36.60 | 18.28 | 22.08 | 2.08 |
| | 8** | 0-20 | 1.65 | 2.64 | 0.59 | 34.15 | 37.12 | 23.60 | 24.81 | 3.73 |
| | | 20-40 | 1.65 | 2.66 | 0.61 | 33.96 | 37.97 | 20.01 | 22.45 | 2.89 |
| | | 40-60 | 1.66 | 2.66 | 0.60 | 33.31 | 37.59 | 17.46 | 20.00 | 2.29 |
| | 9*** | 0-20 | 1.62 | 2.62 | 0.62 | 35.17 | 38.17 | 21.27 | 26.40 | 4.03 |
| | | 20-40 | 1.63 | 2.63 | 0.61 | 35.03 | 38.02 | 20.76 | 22.54 | 3.81 |
| | | 40-60 | 1.64 | 2.63 | 0.60 | 34.27 | 37.64 | 20.61 | 21.00 | 3.11 |
| *Calcareous soil* | | | | | | | | | | |
| $S_1$ (0 – 4) | 10* | 0-20 | 1.58 | 2.62 | 0.66 | 34.23 | 39.69 | 17.02 | 25.59 | 4.08 |
| | | 20-40 | 1.59 | 2.62 | 0.65 | 33.07 | 39.31 | 13.36 | 24.91 | 3.20 |
| | 11** | 0-20 | 1.55 | 2.63 | 0.70 | 35.03 | 41.06 | 20.21 | 28.23 | 5.07 |
| | | 20-40 | 1.58 | 2.64 | 0.67 | 33.61 | 40.15 | 20.60 | 26.65 | 3.42 |
| | | 40-60 | 1.58 | 2.64 | 0.67 | 32.77 | 40.15 | 19.74 | 24.00 | 2.93 |
| | 12*** | 0-20 | 1.51 | 2.63 | 0.74 | 35.73 | 42.59 | 21.58 | 31.23 | 5.59 |
| | | 20-40 | 1.52 | 2.63 | 0.73 | 34.59 | 42.21 | 19.50 | 27.21 | 4.57 |
| | | 40-60 | 1.55 | 2.64 | 0.70 | 33.36 | 41.29 | 19.78 | 21.00 | 2.42 |
| $S_2$ (4 – 8) | 13* | 0-20 | 1.59 | 2.62 | 0.64 | 32.62 | 39.31 | 14.04 | 24.73 | 3.73 |
| | | 20-40 | 1.61 | 2.63 | 0.63 | 31.07 | 38.78 | 13.58 | 20.56 | 2.40 |
| | 14** | 0-20 | 1.58 | 2.61 | 0.65 | 32.67 | 39.46 | 18.95 | 25.88 | 4.26 |
| | | 20-40 | 1.60 | 2.61 | 0.63 | 31.89 | 38.70 | 16.11 | 22.31 | 3.17 |
| | | 40-60 | 1.61 | 2.62 | 0.63 | 31.79 | 38.55 | 16.44 | 21.00 | 2.15 |
| | 15*** | 0-20 | 1.51 | 2.63 | 0.74 | 33.53 | 42.59 | 18.38 | 27.50 | 4.83 |
| | | 20-40 | 1.57 | 2.63 | 0.68 | 32.90 | 40.30 | 18.27 | 23.70 | 3.23 |
| | | 40-60 | 1.57 | 2.63 | 0.68 | 31.02 | 40.30 | 18.32 | 22.00 | 2.81 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $S_3$ ( 8 –16 ) | 16* | 0-20 | 1.61 | 2.61 | 0.62 | 30.80 | 38.31 | 11.12 | 20.67 | 3.40 |
| | | 20-40 | 1.63 | 2.62 | 0.60 | 30.00 | 37.79 | 10.11 | 17.39 | 1.81 |
| | 17** | 0-20 | 1.60 | 2.61 | 0.63 | 31.44 | 38.70 | 17.41 | 22.54 | 3.64 |
| | | 20-40 | 1.62 | 2.61 | 0.61 | 30.75 | 37.93 | 16.57 | 20.21 | 3.47 |
| | | 40-60 | 1.62 | 2.62 | 0.62 | 30.76 | 38.55 | 15.73 | 19.00 | 1.81 |
| | 18*** | 0-20 | 1.57 | 2.62 | 0.67 | 32.10 | 40.08 | 18.79 | 25.21 | 3.74 |
| | | 20-40 | 1.58 | 2.63 | 0.66 | 31.22 | 39.92 | 17.40 | 24.56 | 3.35 |
| | | 40-60 | 1.58 | 2.63 | 0.66 | 30.70 | 39.92 | 15.11 | 21.00 | 2.01 |

*Profiles of shallow water table depth ($W_1$), ** medium depth ($W_2$) and *** deep depth ($W_3$)

***e) Pore size distribution:***

The values of pore size distribution, calculated from moisture adsorptions curves and classified according to **Deleehneer and De Boodt (1965)**, are presented in Table (4). The results obtained reveal that increasing the ECe values led to significant increases in the slowly drainable pores (30-9 μ) by 44.08-55.38, 45.54-85.54 and 43.70-82.35% in the Nile alluvial soil vs1.92-4.62, 1.26-13.52 and 9.41-17.94% in the calcareous one at shallow, medium and deep water table depths when soil salinity levels increased from S1 to S2 and S3 levels, respectively. The corresponding decreases in the values of useful pores (30u-0.2 μ) were 2.14-23.84, .30-23.03 and 27-17.07% in the Nile alluvial soil vs, 15.27-28.76, 6.77-23.10 and 15.64-28.38% in the calcareous one at shallow, medium and deep water table depths when soil salinity levels increased from S1 to S2 and S3 levels, respectively.

Also, increasing the soil salinity levels decreased the values of water holding pores (9-0.2 μ) by 9.57-36.50, 6.64-38.80 and 3.33-35.82% in the Nile alluvial soil at shallow, medium and deep water table depths when soil salinity levels increased from S1 to S2 and S3 levels, respectively. The corresponding values in the calcareous soil were 9.84-37.63, 9.38-34.96 and 20.60-40.14, respectively.

As a general view, soil porosity, void ratio and pore size distribution are reduced with both water table depth and ECe values increments for the two studied soils. Such reduction may be due to recharging and repacking of soil particles closer together, in addition to reorientation of soil pores. These findings are in agreement with those of **Prathapar and Mayer (1993)**.

***II. Effects of soil salinity levels and effective soil depths on some plant parameters of sorghum:***

***a) Soil salinity:***

Tables (5 and 6) show the effect of soil salinity levels (ECe) and regression or correlations of vegetative growth, grain yield and its quality of sorghum in both the studied Nile alluvial and calcareous soils during the two successive seasons. The obtained data show that increasing soil salinity levels of the Nile alluvial soil from S1 to S2 and S3 caused significant decreases ranged between 20.35-36.98, 16.97-32.27, 9.77-20.45, 19.70-29.95 and 29.15-57.46% for plant height, panicle length, weight of 1000 grain, protein content and grain yield, respectively. As for the calcareous soil, the corresponding values were 17.31-36.76, 5.72-33.31, 5.69-24.04, 16.19-33.75 and 14.89-59.14 %, respectively. These decreases indicated a severe deteriorating effect occurred as a result of increasing soil salinity on the vegetative growth and yield of sorghum. Also, this may be due to that increasing soil salinity levels may restrict root elongation, extension and development as well as prohibited the seedlings and root emergence, which were all linked to reduction in the plant growth.

Additionally, significant negative regressions and correlations of sorghum growth, yield and quality have been established with soil salinity levels as shown in Table (6). The results indicate the need to maintain low soil salinity levels necessary for producing a maximum sorghum yield of satisfactory quality.

Simple regression analysis of the obtained data in Table (6) shows a pronounced decrease in each of plant height, panicle length, weight of 1000 grain, protein content and grain yield vs salinity levels (ECe) of 9.088, 0.680, 0.865, 0.283 and 0.913 dS/m, respectively, for the mean values of the two successive seasons in the Nile alluvial soil.

The corresponding decreases in plant parameter grown on the calcareous soil, as mean values of successive seasons, reached 7.213, 0.584, 0.948, 0.306 and 0.649 dS/m, respectively. These trends fall in line with those of **DDC-AUC (1999), Bernardo *et al*. (2000) and Radey (2002).**

**Table (4): Total porosity and pore size distribution in the studied soils.**

| Soil salinity, (dS/m) | Profile No. | Depth (cm) | Total porosity $cm^3/cm^3$ | Pore size distribution (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Quickly drainable pores >30 u | Slowly drainable pores 30-9 u | Volume drainable pores >9 u | Water holding pores 9-0.2 u | Capillary pores <9 u | fine capillary pores <0.2 u | Useful pores 30-3 u | Structural porosity >3 u |
| *The Nile alluvial soil* | | | | | | | | | | | |
| $S_1$ (0-4) | 1* | 0-20 | 37.53 | 10.11 | 1.39 | 11.50 | 12.96 | 26.33 | 13.37 | 14.35 | 24.46 |
| | | 20-40 | 36.94 | 9.06 | 2.32 | 11.38 | 10.43 | 26.56 | 16.13 | 12.75 | 21.81 |
| | 2** | 0-20 | 39.03 | 12.29 | 1.43 | 13.72 | 12.93 | 25.31 | 12.38 | 14.36 | 26.65 |
| | | 20-40 | 37.28 | 12.15 | 1.96 | 14.11 | 12.34 | 23.17 | 10.83 | 14.30 | 26.45 |
| | | 40-60 | 37.12 | 10.78 | 2.99 | 13.77 | 12.24 | 23.35 | 11.11 | 15.23 | 26.01 |
| | 3** | 0-20 | 39.80 | 14.92 | 1.76 | 16.68 | 13.62 | 23.12 | 9.50 | 15.38 | 30.30 |
| | | 20-40 | 38.02 | 13.56 | 2.37 | 15.93 | 12.24 | 22.27 | 10.03 | 14.61 | 28.17 |
| | | 40-60 | 35.48 | 10.85 | 3.01 | 13.86 | 12.00 | 21.62 | 9.62 | 15.01 | 25.86 |
| $S_2$ (4–8) | 4* | 0-20 | 36.30 | 9.37 | 2.03 | 11.40 | 10.74 | 24.90 | 14.16 | 12.77 | 22.14 |
| | | 20-40 | 36.12 | 7.80 | 3.32 | 11.12 | 10.42 | 25.00 | 14.58 | 13.74 | 21.54 |
| | 5** | 0-20 | 37.35 | 12.67 | 2.27 | 14.94 | 12.05 | 22.41 | 10.36 | 14.32 | 26.99 |
| | | 20-40 | 37.23 | 10.27 | 2.95 | 13.22 | 11.87 | 24.01 | 12.14 | 14.82 | 25.09 |
| | | 40-60 | 36.40 | 9.22 | 4.08 | 13.30 | 11.10 | 24.10 | 12.00 | 14.18 | 24.40 |
| | 6*** | 0-20 | 38.50 | 13.92 | 2.39 | 16.31 | 12.42 | 22.19 | 9.77 | 14.81 | 28.73 |
| | | 20-40 | 38.07 | 13.18 | 2.98 | 16.16 | 12.26 | 21.91 | 9.65 | 13.24 | 28.42 |
| | | 40-60 | 36.30 | 9.94 | 4.90 | 14.84 | 11.93 | 21.46 | 9.53 | 16.83 | 26.77 |
| $S_3$ (8–16) | 7* | 0-20 | 33.03 | 9.28 | 2.76 | 12.04 | 8.09 | 20.99 | 12.90 | 10.85 | 20.13 |
| | | 20-40 | 31.04 | 8.01 | 2.99 | 11.00 | 6.76 | 20.04 | 13.28 | 9.75 | 17.76 |
| | 8** | 0-20 | 34.15 | 10.67 | 3.17 | 13.84 | 8.19 | 20.31 | 12.12 | 11.36 | 22.03 |
| | | 20-40 | 33.96 | 9.46 | 3.73 | 13.19 | 7.99 | 20.77 | 12.78 | 10.72 | 21.18 |
| | | 40-60 | 33.31 | 8.03 | 4.95 | 12.98 | 6.76 | 20.33 | 13.57 | 11.71 | 19.74 |
| | 9*** | 0-20 | 35.17 | 10.55 | 3.97 | 14.52 | 8.88 | 20.65 | 11.77 | 12.85 | 23.40 |
| | | 20-40 | 35.03 | 9.98 | 4.16 | 14.14 | 8.26 | 20.99 | 12.63 | 12.42 | 22.40 |
| | | 40-60 | 34.27 | 8.84 | 4.90 | 13.74 | 7.65 | 20.53 | 13.38 | 12.05 | 20.89 |
| Calcareous soil | | | | | | | | | | | |
| $S_1$ (0-4) | 10* | 0-20 | 34.23 | 10.03 | 2.34 | 12.37 | 10.00 | 21.86 | 11.86 | 12.34 | 22.37 |
| | | 20-40 | 33.07 | 8.65 | 2.86 | 11.51 | 9.56 | 21.56 | 12.00 | 12.42 | 21.07 |
| | 11** | 0-20 | 35.03 | 10.59 | 2.98 | 13.57 | 10.57 | 21.46 | 10.89 | 13.55 | 24.14 |
| | | 20-40 | 33.61 | 9.52 | 3.06 | 12.58 | 9.99 | 21.03 | 11.04 | 13.05 | 22.57 |
| | | 40-60 | 32.77 | 8.23 | 3.51 | 11.54 | 8.88 | 21.23 | 12..35 | 12.39 | 20.42 |
| | 12*** | 0-20 | 35.73 | 10.30 | 2.83 | 13.13 | 12.31 | 21.60 | 9.29 | 15.14 | 25.44 |
| | | 20-40 | 34.59 | 9.86 | 3.53 | 13.39 | 11.51 | 21.20 | 9.69 | 15.04 | 24.90 |
| | | 40-60 | 33.36 | 9.40 | 3.85 | 13.25 | 10.41 | 20.11 | 9.70 | 14.26 | 23.66 |
| 4 | 13* | 0-20 | 32.62 | 9.40 | 2.55 | 11.95 | 8.53 | 20.67 | 12.14 | 11.08 | 20.48 |
| | | 20-40 | 31.07 | 8.83 | 2.75 | 11.58 | 7.14 | 19.49 | 12.35 | 9.89 | 18.72 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14** | 0-20 | 32.67 | 10.55 | 3.25 | 13.80 | 10.07 | 18.87 | 8.80 | 13.32 | 23.87 |
| | | 20-40 | 31.89 | 9.20 | 3.27 | 12.47 | 8.92 | 19.42 | 10.50 | 12.19 | 21.39 |
| | | 40-60 | 31.79 | 8.69 | 3.15 | 11.84 | 7.67 | 19.95 | 12.28 | 10.82 | 19.51 |
| | 15*** | 0-20 | 33.53 | 11.31 | 3.23 | 14.54 | 10.65 | 19.99 | 9.34 | 13.88 | 25.19 |
| | | 20-40 | 32.90 | 9.38 | 3.80 | 13.92 | 8.49 | 19.66 | 11.49 | 12.35 | 21.41 |
| | | 40-60 | 31.02 | 9.31 | 4.06 | 13.37 | 8.04 | 17.65 | 9.61 | 12.10 | 21.41 |
| $S_3$ (8–16) | 16* | 0-20 | 30.80 | 7.85 | 2.64 | 10.49 | 6.29 | 20.31 | 14.02 | 8.93 | 16.78 |
| | | 20-40 | 30.00 | 7.88 | 2.80 | 9.68 | 5.91 | 20.32 | 14.41 | 8.71 | 15.59 |
| | 17** | 0-20 | 31.44 | 9.36 | 3.41 | 13.77 | 7.10 | 17.67 | 10.57 | 10.51 | 20.87 |
| | | 20-40 | 30.75 | 8.59 | 3.67 | 12.26 | 6.09 | 18.49 | 12.40 | 9.76 | 18.35 |
| | | 40-60 | 30.76 | 7.84 | 3.74 | 11.58 | 5.96 | 19.18 | 13.22 | 9.70 | 17.54 |
| | 18*** | 0-20 | 32.10 | 9.60 | 3.86 | 13.46 | 7.14 | 18.64 | 11.50 | 11.00 | 20.60 |
| | | 20-40 | 31.22 | 8.59 | 4.04 | 12.63 | 7.24 | 18.59 | 11.35 | 11.28 | 19.87 |
| | | 40-60 | 30.70 | 8.00 | 4.14 | 12.14 | 6.12 | 18.56 | 12.44 | 10.26 | 18.26 |

* Profiles of shallow water table depth ($W_1$),** medium depth ($W_2$) and*** deep depth ($W_3$)

***b) Effective soil depth as related to some plant parameters of sorghum*:**

Data presented in Table (7) show the effect of soil depth as expressed by water table depth on some plant parameters of sorghum. In the Nile alluvial soil, increasing water table depth from shallow ($W_1 \approx$55 cm) to medium ($W_2 \approx$ 80cm) and deep water table depth ($W_3 \approx$ 120 cm) caused significant increases in plant parameters reached 20.59-32.48, 13.52-24.13, 9.67-11.64, 4.10-11.78 and 70.82-86.55% for plant height, panicle length, weight of 1000 grain protein content and grain yield, respectively, as percentages for mean values of two successive seasons as compared to the deep ground water table. The corresponding values for the calcareous soil were 24.38-34.52, 8.91-18.19, 8.58-11.97, 7.91-16.51 and 68.62-86.18 %, respectively.

Concerning simple regression analysis, the obtained data in Table (8) show that there was a pronounced decrease in each of plant height (cm), panicle length (cm), weight of 1000 grain (g), protein content % and grain yield (ardeb/fed) for sorghum reached 0.743, 0.497, 0.073, 0.013 and 0.059 for every depth unit (cm) of water table depth increment, respectively, for the mean values of two successive seasons in the Nile alluvial soil. However, these plant parameters were 7.39, 4.25, 0.49, 0.16 and 0.35 for every 10 cm of ground water table depth increment, respectively, for the mean values of two successive seasons in the calcareous soil. Fluctuations in water table depths resulted in significant changes in some soil properties, and this may reflect upon vegetative growth, yield and grain quality of the studied sorghum crop. These findings are in agreement with those of **Jury *et al.* (1991) and Paratap *et al.* (1994)**.

***c) Effect of both soil salinity and water table levels on some plant characters:***

The interaction effects of both water table depth and soil salinity levels on some plant characters and grain yield are shown in Tables (9 and 10). Water tables depth (55-80 cm) reduces both vegetative growth and grain yield of sorghum, while the depth of 120 cm gave the highest yield even in saline soils (ECe=4-8.0 dS/m). As can be seen in those tables, the highest values of the plant height (cm), panicle length (cm), weight of 1000 grain (g), protein content % and grain yield (ardeb/fed.), which are presented at normal soils ($S_1$) with deep water table depth ($W_3$), were 284.23, 22.85, 42.48, 11.36 and 18.83, respectively, in the growing season of 2002 vs 282.76, 22.93, 43.30, 11.88 and 18.33 in season of 2003 for the Nile alluvial soil. The corresponding values in the calcareous soil were 257.90, 20.40, 39.13, 10.95 and 16.12, respectively, in season of 2002 vs 262.70, 19.96, 39.31, 10.33 and 15.66, respectively in season of 2003.

On the other hand, the lowest values of sorghum parameters, i.e., plant height (cm), panicle length (cm), weight of 1000 grain (g), protein content % and grain yield (ardeb/fed) were 148.05, 12.25, 30.60, 6.30 and 5.34, respectively in 1st season (2002) vs 149.75, 12.40, 29.63, 6.89 and 4.59, respectively in 2nd season (2003) for the Nile alluvial soil. The corresponding values in the calcareous soil were135.20, 10.40, 25.78, 6.27 and 3.79 in 1st season (2002) vs 129.18, 11.05, 26.63, 5.55 and 4.11, respectively in 2nd season of 2003. Also, the lowest values are presented in highly saline soils ($S_3$, ECe=8-16 dS/m) with shallow water table depth ($W_1$=55 cm,). These results may be attributed to the fact that exposure to salinity during growth induces stunted growth and structural changes at various levels of organization. In addition, increasing the salt osmotic potential in root rizosphere at the saline and highly saline soils led to decrease absorption and availability of water and nutrients.

Table 5, 6

Table 7, 8

Table 9

Multiple regression analysis, were applied to determine the partial quantitative effect for each of soil salinity levels (ECe) and water table depth on some plant parameters of sorghum, which are shown in Table (10). The obtained relations between plant parameters (y) and soil salinity levels ($x_1$) and water table depths ($x_2$) during the two successive seasons of 2002 and 2003 at the two studied soil sites show that an increase in every unit of ECe in dS/m and water table depth in 10 cm led to decrease or increase the values of grain yield (ardeb/fed) of sorghum by 0.809 and 0.843 at season 2002, and by 0.889 and 0.674 at season 2003, respectively, for the Nile alluvial soil vs 0.645 and 0.789 at season 2002 and 0.606 and 0.660 at season 2003, respectively, for the calcareous one.

According to the above illustrated results and discussion, it could be concluded that the best results of plant growth, yield and quality of grains of sorghum crop require that all environmental factors to be favourable, i.e., water table depth of 120 cm and low soil salinity (ECe), which are necessary for producing a maximum grain yield of satisfactory quality.

**EFERENCES:**

**Abdel Motaleb, M.H. (1997).** Studies on monitoring of desertification and land degradation processes at El- Fayoum depression, Egypt. M. Sc. Thesis, Fac.of Agric. El-Fayoum, Cairo Univ. Egypt.

**Ali, I. N.; Abdel- Aal, S.A.; Mohamed, I.I. and Mohamed, M.M. (2000**). Preventing degradation of soils under saline ground water table. Egypt. Soil Sci. Golden Jubilee Congress, Oct. 23 – 25, 2000 Cairo, Egypt.

**Bernardo, M.A.; Dieguez, E.T. ;Jones, H.G.; Chairez. F.A.; Ojanuren, C.L. and Cortes, A.L. (2000).** Screening and classification of cowpea genotypes for salt tolerance during germination. Int. J. Exp. Bot,. 67: 71-84.

**DDC -AUC. (1999) .**Evaluating water quality for agriculture and management of salinity problems. DDC – AUC Research Station, Soil and Water Group Bull ‹No, I.

**Deleehneer, L .and De Boodt, M. (1965**). Soil Physical. International Training Center for Post- Graduates. Soil Scientists, Ghent, Belgium.

**El Samnoudi, L.M. and Abou- Arab, A.A. (2000 a).**. Influence of some soil physical properties on water movement of clayey soils in Fayoum depression **.**Egypt. Soil Sci. Golden Jubilee Congress, Oct. 23 – 25, 2000, Cairo, Egypt.

**El Samnoudi. I.M. and Abou Arab. A.A. (2000b).** Soil salinity effect on growth and yield grains quality of sorghum crop. Egypt Soil Sci. Golden Jubilee Congress, Oct. 23 – 25, 2000, Cairo, Egypt.

**FAO. (1991)**. World Soil Resources, World Soil Resources Report, 60, Rome, Italy.

**Ghassemi, F. A.:Jakeman J. and Nix, H. A. (1995).** Salinization of land and water resources. Center for Resource and Environmental Studies. The Australian National University. Canberra. ACT 0200. Australia.

**Hafez, A.R. and Hikkelsen, O.S. (1981 ).** Calorimetric determination of nitrogen for evaluating the nutritional status of rice. Communications Soil Sci., and Plant Analysis, 1291:16 – 69.

**Ibrahim, S.M.; Koriem, M.A. and Gaheen, S.A. (2003).** Water table fluctuation and salinity in relation to land water management systems. Egypt. J., Soil Sci., 43 (2): 285-301.

**Jury, W.A.; Gardner, W.R. and Gardner, W.H. (1991).** "Soil Physics.'' John Wiley & Sons, New York., U.S.A.

**Klute, A. (Ed). (1986).** Methods of Soil Analysis-Part 1: Physical and Mineralogical Methods. 2 nd ed., Amer. Soc. of Agron., Madison, Wisconsin, U. S.A.

**Morrison, R.D. (1983)** . Ground Water Monitoring: Technology, Procedures Equipment's and Application." Inc. Wisconsin, U.S.A.

**Navada, S.V.; Nair, A.R.; Paliwall, B.I. and Doshi, C.S. (1993).** Ground water recharge studies in arid region of Jalore, Rajasthan using isotope techniques. J., arid Environ., 24: 125-133.

**Olesen, T.; Moldrup, P. and Henriksen, K. (1997).** Modeling diffusion and reaction in soils, VI: Ion diffusion and water characteristics in organic manure amended soil. Soil Sci., 162: 299 – 306**.**

**Page, A.I.; Miller, R.H. and Keeney, D.R. (Eds). (1982).** Methods of Soil Analysis, Part- 2.Chemical and Microbiological Properties.2nd (Ed). Amer. Soc. of Agron., Madison, Wisconsin, U. S. A.

**Paratap, S.; Kumar, R. ;Singh, P. and Ranwer, K. (1994).** Evapotranspiration from wheat under a semi- arid climate and shallow water table. Agricultural Water Management, 23: 91-108.

**Prathapar, S.A. and Meyer, W.S. (1993).** Measurement and estimation of capillary upflow from water tables under maize in irrigated soils, Aust. J., Soil Res., 31:119-130

**Radey, M.M. (2002).** Response of propolis extract- presoaking seeds of some crops to salt tolerance under different soil conditions.Ph.D. Thesis Fac. of Agric., El- Fayoum Cairo Univ., Egypt.

**Snedecor, G.W. and Cochran, W. G. (1980).** Statistical Methods. 7th (Ed), Iowa, State Univ., Iowa U.S.A.

## تأثير مستويات من الملوحة والعمق الفعال للتربة على انتاجية الذرة الرفيعة النامية فى بعض الاراضى النهرية الرسوبية والجيرية تحت ظروف الفيوم

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تهدف هذه الدراسة إلى تقييم تأثير مستويات من الملوحة (عادية ECe = < ٤، متوسطة ٤-٨، ملحية ٨-١٦ ديسيسيمنز/م)، والعمق الفعال للتربة (٥٥، ٨٠، ١٢٠ سم) على إنتاجية نباتات الذرة الرفيعة (جيزة ١٥) النامية فى بعض الاراضى النهرية الرسوبية والجيرية خلال موسمين زراعيين متتاليين (٢٠٠٠٢/ ٢٠٠٣) تحت ظروف محافظة الفيوم.

ولتحقيق أهداف هذه الدراسة تم اختيار موقعين بمركزى سنورس (أراضي نهرية رسوبية) والفيوم (أراضي جيرية)، وفى كل موقع تم اختيار ثلاثة أماكن مختلفة فى العمق الفعال للتربة (ماء أرضى سطحى ≈ ٥٥ سم، متوسط ≈ ٨٠ سم، عميق ≈ ١٢٠ سم)، كما تشتمل المساحة التى يمثلها كل عمق من الاعماق الفعالة للتربة على ثلاث مستويات من الملوحة (قيم التوصيل الكهربي لها أقل من ٤، ٤-٨، ٨-١٦ ديسسيمنز/متر).

وتوضح النتائج المتحصل عليها أن هناك تأثير كبير لكل من مستويات الملوحة وأعماق التربة الفعالة على قيم الكثافة الظاهرية، المسامية الكلية، نسبة المسام والمسام الهوائية، التوزيع الحجمى للمسام، المحتوى من الماء الممسوك والمنقول خلال التربة على إمتداد موسمى الزراعة، بالإضافة إلى أن زيادة مستويات الملوحة قد نتج عنها نقص معنوي في قيم بعض قياسات النمو الخضرى والمحصول ومكوناته (طول النبات، طول النوره، وزن الألف حبة، المحصول من الحبوب، نسبة البروتين في الحبوب)، حيث حدث نقص فى قيمها وصل إلى ٣٦.٩٨٪ في طول النبات، ٣٢.٢٧٪ في طول القنديل، ٢٠.٤٥٪ في وزن الألف حبة، ٢٩.٩٥٪ في نسبة البروتين في الحبوب، ٥٧.٤٦٪ في محصول الحبوب وذلك بالنسبة للأراضى النهرية الرسوبية عند ارتفاع ملوحة التربة من المستوى الاول (غير ملحية) الى المستوى الثالث (شديدة الملوحة)، بينما وصل النقص فى الأراضى الجيرية إلى ٣٦.٧٦٪ في طول النبات، ٣٣.٣١٪ في طول القنديل، ٢٤.٥٤٪ في وزن الألف حبة، ٣٣.٧٥٪ في نسبة البروتين في الحبوب، ٥٩.١٤٪ في محصول الحبوب.

كما وجد أن نقص عمق التربة الفعال من ≈ ١٢٠ سم إلى ≈ ٥٥ سم قد أدى الى نقص فى قيم القياسات النباتية لمحصول الذرة الرفيعة المشار إليها سابقا فى الأراضى النهرية الرسوبية وصل إلى ٣٢.٤٨٪ في طول النبات، ٢٤.١٨٪ في طول القنديل، ١١.٦٤٪ فى وزن الالف حبة، ١١.٧٨٪ فى نسبة البروتين، ٨٦.٥٥٪ فى محصول الحبوب، أما بالنسبة للأرض الجيرية فقد وصل النقص إلى ٣٤.٥٢٪ فى طول النبات، ١٨.١٩٪ فى طول القنديل، ١١.٩٧٪ فى وزن الف حبة، ٦.٥١٪ فى نسبة البروتين في الحبوب، ٨٦.١٨٪ فى محصول الحبوب .

ويتضح من التحليل الاحصائى أن التأثير العكسى للمعاملات المشتركة ما بين مستويات الملوحة وعمق التربة الفعال والقياسات النباتية لمحصول الذرة الرفيعة قد تم إيضاحه، وتشير النتائج إلى أنه للحصول على أعلى إنتاجية من محصول الذرة الرفيعة يجب الإهتمام بخفض مستوى ملوحة التربة، وكذلك العمل على خفض مستوى الماء الأرضى للوصول إلى العمق الفعال للتربة (عميق= >١٢٠ سم) طبقا لمعاملات الدراسة.