O 39. EFFECT OF SALINE SOILS AND WATER QUALITY ON SOME COTTON TRAITS UNDER DIFFERENT LOCATIONS

E. H. El-Seidy[1*], S. A. Shaker[2], Hanan El- Ganayny[2]

[1]*Agron.Dep., Fac. Agric., Tanta Univ.*
[2]*Cotton Res. Inst., Agric. Res. Center, Giza, Egypt*

E-mail*: drsayed176@gmail.com, Emannabel923@gmail.com, shroukhassan1998@gmail.com*

ABSTRACT: The main objectives of this study have been conducted to evaluate the effect of different locations as affected by salinity on yield and some yield components for cotton varieties. Field conditions vary from location to another as affected by soil salinity and water quality so, the gene expression differs accordingly to this condition. The seven varieties in this study were evaluated from Extra-long staple category (Giza 87, Giza 88, Giza 92, Giza 93 and Giza 96) and the long staple category (Giza 86 and Giza 94) and these varieties were grown at seven locations in Lower Egypt (Delta) over the two growing seasons of 2013 and 2014 in a randomized complete block design with four replications. Variance components over locations was calculated for earliness, cotton yield and yield components. Kafr Saad location recorded the desirable traits i.e. seed cotton yield (kf), Lint cotton yield (kf), boll weight (g), seed index (g) and lint index (g). Effect of locations were significant for all studied characters. Alexandria location more early than the other locations, also Damietta location recorded the best values for most studied traits.

Keywords: Location, Soil Salinity and Irrigation Water Quality

1. INTRODUCTION

Arid and semiarid regions of the world are being faced by soil salinization which is hampering crop growth in these areas (Ghulam *et al*., 2013). Soil salinity causes great losses to agriculture by lowering the yields of various crops, especially cotton. Salinization of soil creates extremely unfavorable conditions for plant growth. Salt tolerance of plants is linked way connected with light tolerance. All genotypes do not respond in a similar way to changes of the environment, therefore screening of genotypes for stability under varying environmental conditions has thus become an essential part of modern breeding programmers. Soil salinization is one of the important biotic stress which results in the reduction of growth and productivity of the crops (Sairam *et al*., 2002). It affects crops mainly in two ways i.e. either by osmotic effect or by specific ion effect (Munns and James, 2019). Higher levels of soluble salts in soil mainly cause an increase in osmotic pressure; consequently, plants are impeded to uptake water and nutrients from the soil (Abrol *et al*., 1988). Osmotic effect causes disruption in osmotic potentials, were as specific ion effect causes toxicity of different ions (Brady and Weil, 2002). High salt concentrations disturb the ionic homeostasis and produce reactive oxygen species (Saqib et al., 2008). It has been observed that in saline soils, the concentration of Na^+ and CL^- is higher accompanied with the decreased concentration of K^+ and K^+: Na^+ ratio thus severely affecting the plant growth (Saqib et al., 2004). The studies about the effects of saline water irrigation on crops mainly focused on various plant growth parameters and grain yield. (Song et al., 2016) showed that the salinity of saline water at 2 g. L^{-1} would promote the accumulation of cotton dry matter, but the accumulation of dry matter decreased with the increasing of irrigation water salinity when the salinity was above 4 g. L^{-1}. With saline soil irrigation, soil salinity used to be one of the major considerations. The influence of saline water irrigation on soil salinity concentrated on soil salt accumulation/desalinization (Jingang et al., 2019).

The main objectives of this study have been conducted to assess the effect of different locations as affected by salinity on yield and some yield components for cotton.

2. MATERIALS AND METHODS

The materials used in the present investigation included seven Egyptian cotton varieties, (*G. barbadense* L.) belonging to the two categories: (1) Long staple, i.e. Giza 86 and Giza 94 and (2) Extra long staple, i.e. Giza 87, Giza 88, Giza 92, Giza 93 and Giza 96.

Field experiments were carried out to evaluate of seven genotypes at seven different locations in the North of Egypt i.e, Alexandria, El-Behera (Damnhour and Edko), Kafr El-Sheikh (Kafr El-Sheikh and Sedi Salem) and Damietta (Kafr Saad and Kafr El-Batekh) during the two growing seasons 2013 and 2014. The experimental design was a complete randomized block design with four replications. The sowing date was in the second week of April for both seasons. The plot size was 52 m^2, 65 cm apart ridges and 25 cm between hills.

2.1. The studied characters were as follows:

- Earliness measurements:

$$\text{Earliness \% (Ear \%)} = \frac{\text{Weight of seed cotton yield in the first pick}}{\text{Weight of seed cotton yield in the two picks}} \times 100 \qquad .1$$

2. Position of the first fruiting node (FFN): The node number on the main stem giving the first fruiting branch according to Richmond and Radwan (1962).

- Yield and yield components:

Seed cotton yield (SCY) (K/F), Lint cotton yield (LCY) (K/F), Boll weight (BW) (g), Lint percentage (LP) (%), Seed Index (SI).and Lint index (LI) (g).

2.2. Statistical analysis:

The standard analysis of variance was computed for each experiment, combined analysis for locations was done according to Snedecor and Cochran (l982). Before calculating, the combined analysis a Bartlett test, 1937 for the homogeneity of error mean squares for the fourteen environments was calculated. Differences among means were tested by Duncan's multiple range tests.

Table (1):Mean chemical analysis values of soil profile under different locations before cotton planting (2013 and 2014 seasons)

Loc.	pH 1:2.5	EC dS/m	SAR	ESP	Cations				Anions			
					Na^+	Ca^{++}	Mg^{++}	K^+	$CO_3^=$	$HCO_3^=$	Cl^-	$SO_4^=$
Alexandria	8.22	4.63	10.53	12.45	31.50	7.40	10.20	0.37	-	2.17	25.43	21.87
Damanhour	8.16	5.30	11.32	13.35	36.03	8.47	11.67	0.43	-	3.17	28.23	25.20
Edko	8.05	5.48	12.36	14.51	37.27	11.50	6.57	0.83	-	4.50	27.73	23.9
Kafr El-Sheikh	8.22	5.58	11.60	13.67	37.90	8.93	12.30	0.57	-	4.67	30.20	24.83
Sedi Salem	8.21	6.30	12.32	14.43	42.80	10.07	13.87	0.47	-	6.17	33.00	28.03
Kafr Saad	8.28	6.95	12.98	15.05	47.23	11.10	15.27	0.80	-	6.85	36.77	30.78
Kafr El-Bateikh	8.11	4.59	10.53	12.78	31.20	7.33	10.10	0.37	-	2.33	25.83	20.83

Location: In this study, we used locations differed in type of soils and quality of irrigation water.

Soil samples: Before the treatments layout random soil samples (0-30, 30-60 and 60-90 cm depth) were collected and composite (Table 1) composite soil samples were dried, sieved through 2 mm mesh for the following analysis:

Soil analysis:

- Soil reaction (pH) was measured in 1:2.5 soil: water suspension according to **Cottenie *et al.* (1982).**

- **Electrical conductivity (ECe)** was measured by electrical conductivity meter model Jenway, 4320 as dS/m at 25ºC in soil paste extract according to **Page (1982).**
- **Soluble calcium and magnesium** in soil paste extract were determined by using versenate method (**Page, 1982).**
- Soluble sodium and potassium were estimated by a Flame Photometer (**Page, 1982).**
- Soluble carbonate and bicarbonate were determined by titration with a standard HCl solution (**Page, 1982).**
- Soluble chloride was determined by titration with a standard silver nitrate solution (**Page, 1982)**, and sulphate were calculated by the difference beween the sum of soluble cations and anions.
- Exchangeable sodium percentage (ESP) was calculated according to **Gazia (2001):** ESP = -0.9943 + 1.4107 (SAR) – 0.0133 $(SAR)^2$

Criterion of soil salinity

It was calculated according to **Richards (1969)** are shown in Table (2).

Table (2): Criterion soil salinity.

Soil	Saline	Sodic	Saline-sodic
EC (dS/m)	>4	<4	>4
ESP%	<15	>15	>15
pH	<8.5	>8.5	>8.5 (rarely)

Table (3):

Location	pH 1:2.5	EC dS/m	SAR	Cations				Anions			
				Na^+	Ca^{++}	Mg^{++}	K^+	$CO_3^=$	$HCO_3^=$	Cl^-	$SO_4^=$
Alexandria	8.11	1.35	6.15	9.2	2.8	1.6	0.7	-	2.5	7.4	4.4
Damanhour	7.89	0.55	3.61	3.70	0.90	1.20	0.20	-	1.50	2.60	1.80
Edko	8.05	1.32	5.69	9.00	2.10	2.90	0.60	-	2.50	6.30	5.80
KafrElSheikh	7.91	0.61	3.82	4.10	1.00	1.30	0.20	-	1.50	2.90	2.30
Sedi Salem	7.98	0.95	4.84	6.50	1.50	2.10	0.20	-	1.50	4.50	4.20
Kafr Saad	7.95	0.78	4.40	5.30	1.20	1.70	0.20	-	1.50	3.70	3.30
Kafr ElBateikh	8.23	1.51	6.10	10.30	2.40	3.30	0.50	-	2.00	7.20	7.30

Water quality criteria:

It was calculated according to **Eaton (1950), Doneen (1954)** and **Richards (1969),** are shown in Table (4).

Table (4): Water quality criteria

Criterion	Low	Medium	High	Very high
EC (dS/m) Ppm	0.1-0.25 64-160	0.25-0.75 160-480	0.75-2.25 480-1440	>2.25 >14.40
SAR	0-10	10-18	18-26	>26
RSC, meq/L	<1.25	1.25-2.50	>2.50	
Na%	<60	60-75	>75	
B, ppm	<0.5	0.5-2.0	>2	
Cl^-, meq/L	<5	5-10	>10	

Sodium adsorption ratio (SAR) was measured according to the following formula

$$SAR = \frac{Na}{\sqrt{\frac{Ca + mg}{z}}}$$ **ions in meq/L**

Where:

SAR = Sodium adsorption ratio
Na^+, Ca^{++} and Mg^{++} are the concentrations of ions in meq/L
RSC = (CO_3^- + HCO_3^-)-(Ca^{++}+Mg^{++}) ions in meq/L

Where
Residual sodium carbonate (RSC) was measured according to the following formula

$$RSC = Na\% = \frac{Na^+}{Ca^{++} + Mg^{++} + Na^+} x10o$$

Where:
Na% = Sodium percentage

3. RESULTS AND DISCUSSION
3.1. Soil and water analysis:

Chemical analysis values of soil profile and irrigation water under seven locations are tabulated in Tables (1 and 3) and data of soil salinity and water quality are presented in Tables (2 and 4). The salt tolerance of plants is a very acute problem in agriculture. It attracted the attention of many investigators and practical agricultural workers because of the need to increase yields in saline soils and to develop and utilize new saline areas Esawy *et al.*,(2019) and Jingang Li *et al.*,(2019). As shown in Tables (1 and 2), soils are considered good soils if the EC is less than 4 mmhos and pH 7. But, if the EC is more than 4 mmhos the soil is high saline soils and the sensitive crops are affected. The soil is considered as moderate saline if the EC is less than 4 mmhos and pH less than 8.5 accompanied with the exchangeable sodium less than 15 (Table 2). In the various localities under study, the EC ranged between 4.59 (Kafr El-Batiekh) and 6.95 (Kafr Saad). These soils are considered as moderate saline. Some soils seem to be good soils as the EC is about 4, some other soils are moderate or high saline soils when the EC was more than 4. Field conditions vary from location to another, not only in soil salinity, but also in soil chemical properties such as sodicity, high pH and EC interaction between them. Cotton is considered as moderate affected with moderate salinity. Cotton gives full yield (100%) at EC 7.7 and EC of irrigation water 5.1 and the yield is affected to 50% at soil salinity at EC 17.

At locations of the study, EC ranged between 4.59-6.95 and considered as moderate saline soils. Due to the effect of high concentrations of salts in the soil, the relation of the plants to its environment is changed. For example, such factors as temperature and light, which have a favorable effect under normal conditions, may exert an unfavorable effect under saline conditions (Stragonov, 1964).

Apparently, under extremely adverse conditions, which are often met on saline soils, the effect of salt on the plant is expressed by a change of the state of the protoplasm in cells, as a result of the effects of the salts, the protoplasm retreats from the cell wall. This causes a destruction of the plasmodesmata and a disturbance of the intercellular connections between some of the cells.

In general, saline soils induce a retraction of the protoplasm from the cell wall, and that as a result intercellular connection are broken. When the substrate is desalinized, the normal and condition of the protoplasm is restored, including intercellular connections, and this provides evidence for the reversibility of the process.

Under conditions of our study, EC of irrigation water at Kafr El-Batteikh was the highest value (1.51), followed by Alexandria with value (1.35) and Edko with value (1.32). Relatively, the other locations were non saline water that did not reach more than 0.95 EC (Tables 3 and 4). The decreases under Kafr El-Batekh location, may be due to the toxic effect of salts on the somatic cells of the reproductive organs of cotton is the cause of the stunting of the flower, ovaries and bolls. These causes may be due to the highest EC (1.51 dS/m) and pH (8.23) in water quality under Kafr El- Batekh location (Table 4). These results agreed with Saqib *et al*., 2004 who stated that in saline soils, the concentration of Na^+ and CL^- is higher accompanied with the decreased concentration of K^+ and K^+: Na^+ ratio thus severely affecting the plant growth.

This view is supported by the findings that, with few exceptions, the carbohydrate content and content of nitrogenous compounds is usually higher in plants from saline soils than in the same species of plants from non-saline soils. Apparently in such plants, the accumulation of carbohydrates and nitrogenous substances is more rapid than their utilization for the formation of new cells and tissues. It may be assumed that under conditions favorable for growth, these substances accumulate as storage products in the plant organs. When the salt concentration of the soil decreases and the conditions for growth are improved, the carbohydrates and nitrogenous substances are rapidly utilized for the formation of new organs. Such a concept can satisfactorily explain the periodicity of growth of plants grown on irrigated saline soils.

Although all localities are in the range of medium salinity, Kafr El-Bateikh gave the lowest yield of seed cotton, lint cotton and boll weight due to high EC of irrigation.

Strogonov (1964) stated that the movement of minerals from the root into the aerial organs of the plant is *via* phloem when the salt content of the plant is low, while, when the salt content is high, the movement is through the xylem, in the transpiration stream. Under saline conditions, the saturation of plant tissues with salts takes place very rapidly; the further absorption of minerals is determined by the rate of transpiration. The role of transpiration increases when the root system, due to salt damage, loses its regulation ability and non-nutrient salts, dragged in by the transpiration stream, accumulate in the organs of the plant. It can be seen that, the growth and development of cotton on saline soils depends not so much on the total salt content, but on the ratio between the different salts in the soil. The type of salinity in the soil determines the rate of growth and development of the plant.

Unfavorable effects of salts are accompanied by disturbances, in the plant tissues, of the normal balance between the basic mineral nutrient elements.

Soil salinity causes an unfavorable balance between potassium and calcium. The excess of easily soluble salts in the soil affects unfavorably the absorption of nutrient substances by the plant. The opinion of these investigators is that the plant, apart from salt poisoning, also suffers from hunger for essential nutrients.

Seed cotton and lint yields were affected at Kafr El-Sheikh and Sedi Salem less than Kafr Saad, Damanhour, Edko and Alexandria due to the high EC for soils. At Kafr Saad, even the EC of soil was 6.95, but the EC of irrigation water was very low (0.78). Also, both ranged in the moderate phase were found.

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3.2. Effect of locations:

Mean values of earliness, cotton yield and some yield components as affected by different growing locations are presented in Table (5). Before leaving this place, some points need to be tackled. Field conditions vary from site to site, not only in soil salinity, but also in soil chemical properties such as sodicity, high pH and boron and interactions between these stresses can occur. High pH can caused reduced K^+ uptake even though it might not affect Na^+ uptake (Ahmed, 2002) and boron can affect sub cellular distribution of salt in leaves and hence salt tolerance of the plant (Al-Nagar *et al*., 2015).

Table (5): Effect of different locations on earliness, cotton yield and some yield components over two years

Locations / Traits	Alexandria	Damanhour	Edko	Kafr El-Sheikh	Sedi Salem	Kafr Saad	Kafr El-Batekh
% Ear	77.11 ab	73.99 bc	67.01 de	81.11 a	64.52 e	70.69 cd	74.71 bc
FFN	6.00 c	7.15 a	5.63 d	6.98 ab	7.21 a	6.67 b	5.38 d
SCY K/F	10.33 bc	9.42 c	10.48 b	8.40 d	7.60 d	12.32 a	5.95 e
LCY K/F	12.27 b	11.45 b	12.22 b	10.22 c	9.10 d	14.23 a	7.18 e
BW	2.98 b	2.92 b	3.00 ab	2.66 c	2.66 c	3.09 a	2.38 d
LP	37.43 bc	38.45 a	36.79 cd	38.47 a	37.60 b	36.49 d	38.13 ab
SI	10.57 c	9.98 d	10.90 b	9.51 e	9.42 e	11.30 a	9.29 e
L. index	6.39 ab	6.28 b	6.42 ab	5.99 c	5.75 d	6.57 a	5.78 d

Means within the same row with the same letter are not significantly different at 5% level of probability.

From the data presented in Table (5), it could be said that Kafr Saad recorded the desirable traits, i.e. seed cotton yield/fad., lint cotton yield/fad., boll weight, seed index and lint index. The inhibitory effect of increasing salt in the field soils on agronomical and cotton yield traits of observed in the present study was previously reported by several investigators. Salinity stress at different phonological stages inhibits photosynthetic activities of the plant because it had a direct inhibitory effect on the Calvin cycle enzymes (Ottander and Oquist, 1991).

Earliness characters, the cotton genotypes grown at Kafr El-Sheikh and Alexandria were earlier than the other locations (81.11 and 77.11%), respectively. Also, the cotton genotypes grown at Edko and Kafr El-Batekh were better for position of the first fruiting node which had the lowest values (5.63 and 5.38), respectively than the other locations. The increase in salt medium delaying formations of first fruiting node on plants due to the decrease in vegetative growth of cotton plants grown in soil salinity.

Seed cotton yield and it's components, the locations Kafr Saad, Edko and Alexandria recorded the highest values for seed cotton yield and lint cotton yield, because the growing location Kafr Saad recorded the highest values (12.32 and 14.23 kentar/fad.), followed by Alexandria and Edko locations, while Kafr El-Batekh recorded the lowest cotton yield 5.95 and 7.18 kentar/fad., respectively (Table 5). Regarding boll weight, it was the highest for the cotton plants which grown at Kafr Saad and Edko (3.09 g and 3.00 g), respectively, followed by Alexandria location, while at Kafr El-Batekh location, it recorded the lowest boll weight (2.38 g). With respect to lint percentage, it can be seen that the highest values were produced at Kafr El-Sheikh and Damanhour (38.47 and 38.45%), respectively, while the lowest values were produced at Kafr Saad location (36.49%). Regarding seed index, the highest value was produced at Kafr Saad (11.30 g), followed by Edko location (10.90 g), while the lowest value was (9.98 g) at Damanhour location. The highest lint index was produced at Kafr Saad (6.57 g) and not-significant difference with Edko and Alexandria locations (6.42 and 6.39 g), respectively.

A possible explanation is that the formation of bolls and their increase in weight is much more rapid under saline conditions than under non saline ones). The results also indicated that boll weight was more affected by soil salinity, and produced smaller boll. The decrease in boll weight may be due to the decrease of seed index through less of vegetative growth. This reduction in seed cotton yield/plant is mainly due to the reduction in boll weight and number of bolls/plant (N.B./P) as salt concentration increased. It is also cleared from the results that growth and fruiting of cotton plant adversely affected by salinity such effects is mainly due to the effect of salinity on certain physiological function i.e. photosynthesis and transpiration. Pandey and Sinha (1972) observed a decrease in both photosynthesis and transpiration when salinity was increased. In the same time, the results showed that seed index was highly and significantly affected by salinity levels. This reduction in seed index may be due to the decrease in number of good seeds, developed boll and the increase in number of aborted embryos. As for lint percentage (LP%), the results indicated that it was decreased as soil salinity level increased. This reduction in lint percentage may be due to the decrease in seed index. The reduction for obvious traits is sufficient reason for a reduction in yields.

These variations between different locations may be attributed to the effect of soil salinity and water quality criteria (Tables 2 and 4).

These results are in harmony with those obtained by Allam *et al*. (2008), Shaker (2009), Abd El-Bary (2013), Shaker *et al*. (2014), Shaker (2014), Abd El-Samee (2015), Abdbel-Aziz, Eman (2015), El-Ganayny, (2017), El-Seidy *et al.* (2017)and El-Fesheikwy *et al*. (2019) .

They reported that the effect of locations were significant for most previous studied characters.

4. CONCLUSION

The environmental conditions differed from location to another so, the gene expression differs accordingly to this condition. Kafr Saad location recorded the desirable traits *i.e* seed cotton yield (kf), Lint cotton yield (kf), boll weight (g), seed index (g) and lint index (g).

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