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EFFECT OF THE SALINE WATER, IRRIGATION SYSTEMS AND SOYBEAN CULTIVARS ON VEGETATIVE GROWTH AND YIELD

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Abstract

Conventional water resources in Egypt are limited to the Nile River; groundwater in the deserts land Sinai, and precipitation. Each resource has its limitations on use. The present investigation was conducted at National Research Center, El-Noubaria Research Station El-Behaira Governorate, during the two successive seasons of 2015 and 2016 to study the response of three soybean ccltivars: 1- Giza 111, 2- Crawuford, and Giza 35 cultivars, to three salinity stress levels (400, 1200; 2000ppm), irrigation systems (SSD-SD; Sp), and Soybean Cultivars (Giza 111, Crawford; Giza 35) on soybean growth, grain yield. Regarding saline water and irrigation systems, means values of all parameters under study as following: Leaf area index (LAI), Crop growth rate (CGR), Net Assimilation Rate (NAR), Relative Growth Rate (RGR), Grain yield (kg/fed). It could be ranking in the following ascending orders: 400> 1200> 2000 and SP < SD < SSD, respectively. According to all parameters mentioned above, the effect of saline water and irrigation systems on all parameters mentioned above, there is significant differences at the 5 % evel between all values of characters. The interaction between three saline water levels, three irrigation systems and soybean cultivars had significant effect on all parameters mentioned above. It could be concluded to using from 400 to 1200 ppm saline water and subsurface and surface drip irrigation systems to improving soybean growth characters and crop yield.

Keywords: Saline water, Irrigation systems, Growth, Yield, Soybean cultivars.

Introduction

The utilization of such water therefore depends on pumping costs and its depletion rate versus the potential economic return on the long run. Rainfall on the Mediterranean coastal strip decreases eastward from 200 mm/year at Alexandria to75 mm/year at Port Said. It also declines inland to about 25 mm/year near Cairo. In addition to the conventional water resources there are some other non-conventional resources that include renewable groundwater aquifers in the Nile valley and Delta, agricultural drainage water, and treated wastewater.

Irrigation management is one of the most important ingredients to increase the productivity of agricultural crops in the present time, under diverse land use and different irrigation quantity (Mansour *et al.,* 2019a,b,c,d; Eldardiry *et al.*, 2015; El-Hagarey *et al*., 2015, Goyal and Mansour 2015; Ibrahim *et al*., 2018; Mansour 2015). As well as, using simulation models techniques aims to improve the management of water irrigation systems specially under the scarcity of water in the dry climate condition (Mansour *et al*., 2014, 2015a-e, Tayel *et al*., 2012a,b, 2015, 2016, 2018, 2019; Mansour and Aljughaiman 2012, 2015, Mansour and El-Melhem 2012, 2015 and Attia *et al*., 2019).

Cicek and Cakirlat (2002) studied the effect of salinity with different osmotic potential on shoot length, total fresh and dry weight, amounts of organic (proline) and inorganic (K and NA) substance of leaf tissue, the Na / K ratio, and leaf area, relative water content (RWC) and leaf osmolality in two maize cultivars. As a result, the shoot length, total fresh and dry weight and the leaf area decreased, amounts of proline Na, Na / K ratio and the leaf osmolality increased with increasing stress, and salt stress caused a similar decrease in leaf relative water content in both maize cultivars.

Ramoliya and Pandey (2002) Potassium exhibited a rapid decrease in roots while it increased in eaves. These results can be attributed to: (1) transfer of K from roots to leaves, (2) there could have been an exchange of K ions with Na ions in root tissues, and (3) Na could have directly interfered with K uptake.

Hema *et al*. (2003) stated that hydrogen peroxide and lipid hydroperoxides, other potentially toxic reactive oxygen species, are also generated under stress condition. Hydrogen peroxide can cause DNA breakage and can also act to inactive thiol-containing enzymes such as thioredoxin-modulated enzymes of the chloroplasts. all these biochemical changes caused by free radical species may be reflected on depressing growth and yield of plants grown under salinity stress. Salt stress reduces plant growth and yield. The mechanisms by which plant growth is reduced by salt stress are not well understood. Salinity may decrease biomass production due to low / medium water potential. specific ion toxicity or ion imbalance (Mansour *et al*., 2016a), plant protect themselves from ion toxicity by minimizing toxic ions uptake and transport to the shoots.

Saied *et al*. (2005) reported that reduction in the growth of seedlings was also recorded in response to increasing salt stress. In general, salinity can reduce the plant growth or damage the plants through: (1) osmotic effect (Causing water deficit), (2) toxic effects of ions, and (3) imbalance of the uptake of essential nutrients. The cation K is essential for cell expansion, osmoregulation and cellular and whole-plant homeostasis. The role of K in response to salt stress is also well documented, where Na depresses K uptake

Kao *et al.* (2006) has previously reported similar results on reduction of soybean biomass due to salt stress soybean is reported to be a relatively salt sensitive crop Katerji *et al.* (2000) and Kao *et al.* (2006).

Zang (2006) found that water stress during the grain-filling period induces early senescence, reduces photosynthesis, an shortens the grain-filling period, however it increase the remobilization of NSC from the vegetative tissues to the grain. If mild soil drying properly controlled during the later grain-filling period in rice (*Oryza sative*) and wheat (*triticum aestivum)*, it can enhance whole – plant senescence, lead to faster and better remobilization of carbon from vegetative tissues to grains, and accelerate the grain-filling rate. In cases where plant senescence is unfavorably delayed, such as by heavy use of nitrogen and the introduction of hybrids with strong heterosis, the gain from the enhanced remobilization and accelerated grain-filling rate can outweigh the loss of reduced photosynthesis and the shortened grain-filling period, leading to an increased grain yield, better harvest index and higher water – use efficiency. Sakr and El-Metwally (2009) indicated that salinity suppressed both cell division and cell enlargement proportionally in wheat plants. The reduction in plant growth under salinization may be also due to regulation between the endogenous phytohormones present in the plants. (Mansour *et al*., 2016b).

In addition, the inhibitory effect of salinity on growth may be due to decrease in water absorption, metabolic processes, meristematic activity and / or cell enlargement (Khadr *et al.,* 1994), Moreover the decrease in growth due to salinity may be attributed to an increase in respiration rate resulting from higher energy requirement's, there are two ways that salinity could retard growth (a) by damaging growth cells so that they cannot perform their functions or (b) by limiting their supply of essential metabolites, the reduction in plant growth under salinization may be also due to the regulation between the endogenous growth substances presented in the seedling El-Nabarawy (1994). Regarding seedling fresh weight findings reported by Sobhanian *et al.* (2010), attributed the depressing effects of salinity on plant growth to an inhibition on protein turnover and mucleic acid synthesis in plants.

Amirjani (2010) The salinity sensitivity of soybean was studied. The effect of salinity on length and fresh weight of seedling were determined increasing salinity level to 50, 100 and 200 mM resulted in a reduction of plant height of 30, 47 and 76% and a reduction of fresh weight of 32, 54 and respectively.

The Na^+ content significantly as salinity treatment concentrations increased the behavior of antioxidant enzymes was analyzed. A significant decrease in superoxide dismutase, catalase peroxidase activities under 100 and 200 mM salt were found.

The objectives of current research study were to study the effect of different three soybean cultivars, three salinity stress levels and three irrigation systems on soybean growth, grain yield.

Materials and Methods

Field experiments

The present investigation was conducted at National Research Center, El-Noubaria Research Station El-Behaira Governorate, during the two successive seasons of 2015 and 2016 to study the response of three soybean cultivars: 1- Giza 111, 2- Crawuford, and Giza 35 cultivars, on the agronomic characteristics and yield as well as the percentages of oil, protein, Carbohydrates and Amino acids in soybean seeds as technological properties of soybean (*Glycine max* L *Merr.*) were studied.

Table 1 : Soil water properties of National Research Center Research Station.

Site	pH	EC (dSm^{-1})	OM	$CaCO_3$	(Soil water content %vb)		
			%		FC	WP	AW
NRC Farm	8.2	2.6	1.3	3.8	12.6	4.7	7.9

pH: (1.25), EC: electrical conductivity in the extracted soil paste, OM organic matter, FC: field capacity, WP: wilting point, AW available water, vb volume basis.

Table 2 : Some soil physical characteristics.

Depth, cm	Particle Size distribution, %				Texture class	θ_S % on weight basis			HC (cmh^{-1})	BD (g/cm^3)	P (cm^3 voids /cm^3 soil)
	C. Sand	F. Sand	Silt	Clay		F.C.	W.P.	AW			
0-15	8.4	77.6	8.5	5.5	Sandy	14	6	8	6.68	1.69	0.36
15-30	8.6	77.7	8.3	5.4	Sandy	14	6	8	6.84	1.69	0.36
30-45	8.5	77.5	8.8	5.2	Sandy	14	6	8	6.91	1.69	0.36
45-60	8.8	76.7	8.6	5.9	Sandy	14	6	8	6.17	1.67	0.37

F.C.: Field capacity, WP: wilting point, AW: available water, HC: Hydraulic conductivity, BD: Bulk density, and P : Pores of air in soil.

Table 3 : Fresh and saline water mixed characteristics (Mansour *et al.*, 2016a).

Parameters	FW 400 ppm	SW 1200 ppm	SW 2000 ppm
Physical analysis			
EC (dS/m)	1.56	2.4	3.2
pH	7.3	7.3	7.4
TDS (ppm)	0,442	1,236	2,079
Chemical analysis			
Cations			
Ca	5.54	6.8	7.3
Mg	3.8	4.3	5.3
Na	6.2	13.6	22.8
K	0.1	0.2	0.2
Anions			
$HCO_3^=$	0.0	0.0	0.0
HCO_3^{--}	2.4	3.4	3.2
$Cl^=$	8.6	5.8	10.2
$SO4^=$	5.3	6.9	8.4
ASR	2.8	4.9	7.6

TDS: Total dissolved solids, ASR: Aquifer Storage and Recovery

Some soil physical, chemical and water properties of the studied soil are carried out according to (Walter and Gardener, 1986; Klute and Dirksen, 1986; Jackson, 1967; and Soil Survey Staff, Soil Survey 1993) and moisture retention at field capacity and wilting point after (Rebecca, 2004). Soils of both investigated sites were sandy loam in texture. Some soil water characteristics of this experiments were presented in Tables (1, 2 and 3).

The plot area was 21 m^2 (1 x 21). while the Saline water levels was added in association of tested levels as follows:

Saline water:

1- Available irrigation water (FW- 400 ppm)
2- Saline water 1200 ppm (SW-1200 ppm)
3- Saline water 2000 ppm (SW-2000 ppm)

Irrigation system:

Irrigation networks include the following components as shown in Figures (1, 2 and 3):

1. **Control head:** It was located at the water source supply. It consists of centrifugal pump 4`` /4``, driven by diesel engine (pump discharge of $100m^3/h$ and 50m lift), sand media filter 48``(two tanks), screen filter 2`` (120 mesh) back flow prevention device, pressure regulator, pressure gauges, flow-meter, control valves and chemical injection.
2. **Main line:** PVC pipes of 125mm in diameter (OD) to convey the water from the source to the main control points in the field.
3. **Sub-main lines:** PVC pipes of 75mm diameter (OD) were connected to with the main line through a control unit consists of a 2`` ball valve and pressure gauges.
4. **Manifold lines:** PVC pipes of 40mm in diameter (OD) were connected to the sub main line through control valves 1.5``.
5. **Distributors:** Spacing between lines were 0.5m, -Emitters: These emitters (GR) built in PE tubes 16mm in diameter (OD) and 63 m in long (emitter discharge of 4 lph at 1.0 bar operating pressure, 30 cm spacing between emitters.

These component of irrigation systems were installed and operated according to Mansour *et al.* (2014) Mansour (2015), Mansour and Aljughaiman (2015), Mansour and El-Melhem (2015), Mansour *et al.* (2015 a; b) and Mansour *et al.* (2016 a, b; c).

1-Surface drip irrigation systems (SD)

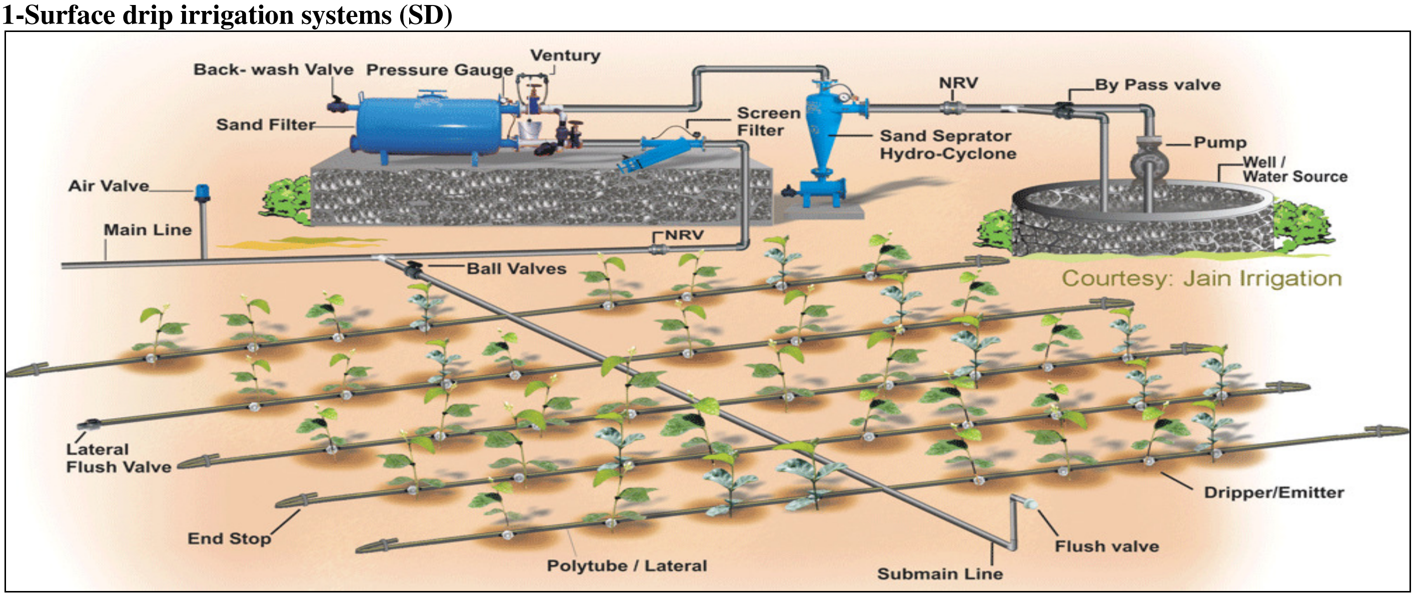

Fig. 3.1 : Layout of drip irrigation system

2-Sub-surface drip irrigation systems(SSD):

Fig. 3.2 : Layout of Subsurface-drip Irrigation system

3-Sprinkler irrigation systems(SP):

Fig. 3.3 : Layout of Sprinkler Irrigation system

Tanks:

Three Polyethylene, 1 m^3 tanks with a float inside was connected to the control head. The tanksare being filled with water through 63 mm pipe PVC - 6 bar, derived from the main line of the farm.

Field experimental layout

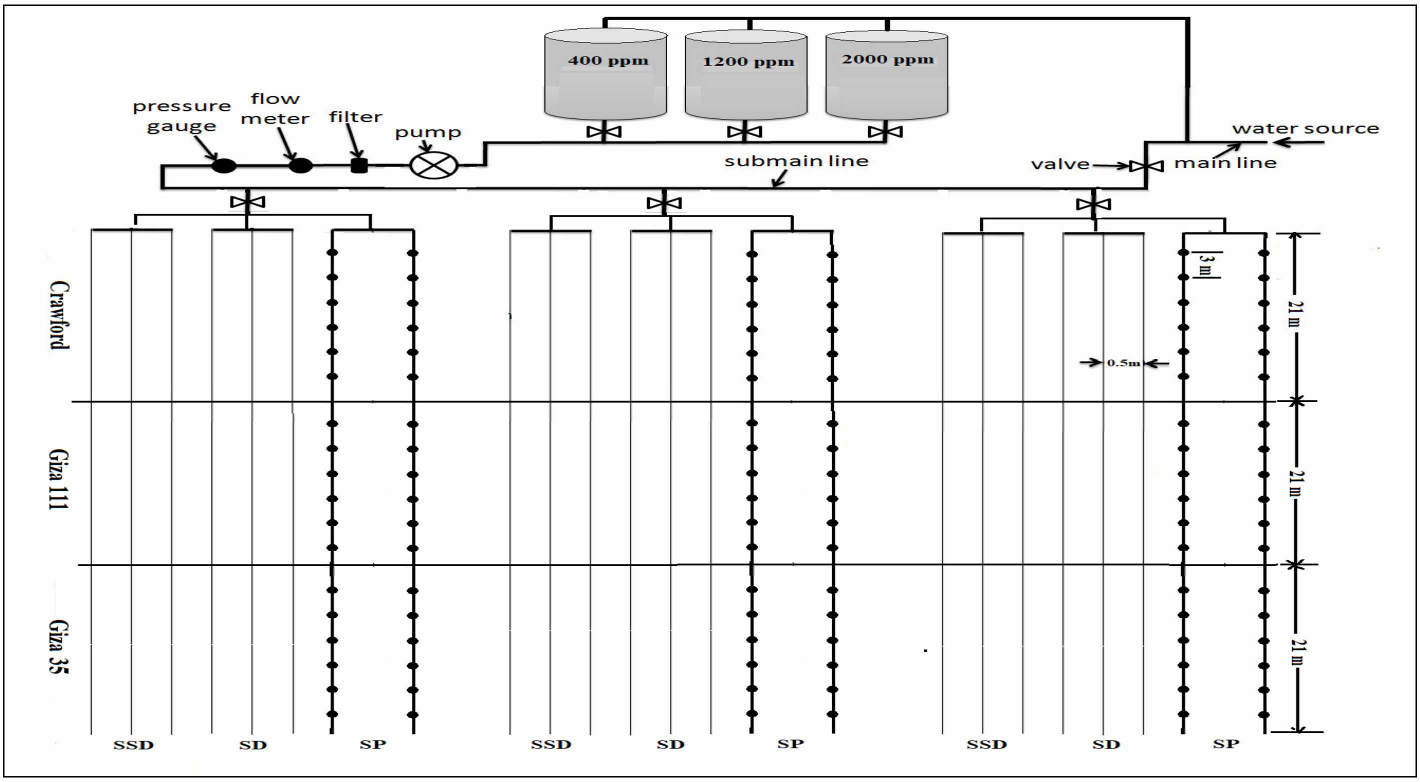

Fig 3.4 : Layout of the field experiments for the effect of different saline water and irrigation systems on different soybean varities at (NRC's Farm, El-Noubaria region, Elbuhaira Governorate).

Soybean cultivars:

1- Giza111

2- Crawford

3- Giza35

Growth characteristics:

Leaf area (cm^2),

Leaf area index (LAI),

$$LAI = \frac{\text{Leaf area}}{\text{Land area occupied by the plant sample}}$$

Where:

LAI: Leaf area index

Crop growth rate) CGR($mg/m^2.d^{-1}$,

$$CGR = \frac{1}{A} \times \frac{W_2 - W_1}{T_2 - T_1}$$

Where:

CGR: crop growth rate

A: *Land area occupied by the plant sample cm^2*

W_2: Dry weight of the plant sample at time T_2

W_1: weight of the plant sample at time T_1

Net Assimilation Rate (NAR) mg/m^2 d^{-1}.,

$$NAR = \frac{CGR}{LAI}$$

Where:

NAR: Net Assimilation Rate

8- Relative Growth Rate (RGR)mg d^{-1}

$$RGR = \frac{LnW_2 - LnW_1}{T_2 - T_1}$$

Where:

LnW_1 : The natural logarithm of dry matter weight at the time of growth T1

LnW_2 : The natural logarithm of dry matter weight at the time of growth T2

Yield and its components:

1-Soybean production (Kg/fed),

2-Straw production (Kg/fed) and

Statistical analysis:

The experiments were laid out in a spilt Split plot design (design with 3 replicates). The data were subjected to the proper statistical analysis of variance according to **Snedecor and Cochran (1980).** Significance of difference among means was compared using least Significant Differences (L.S.D) at 0.05 level of significant.

Results

Leaf area

Data in Table (4(Illustrate the effect of three saline water levels (400ppm, 1200ppm and 2000ppm) on Leaf area for three Cultivars (Giza 111, Crawford and Giza 35) in the first and second seasons 2015 and 2016, respectively. Regarding saline water levels, means values of Leaf area, It could be ranking in the following ascending orders: 2000ppm < 1200ppm < 400ppm. According to Leaf area, the effect of saline water levels on Leaf area**,** there is significant differences at the 5 % level between all values of characters. Regarding to saline water levels, gradually increases were detected by increasing saline water levels, where application of 400ppm ppm under three cultivars (Giza 111, Crawford and Giza 35) achieved the maximum Leaf area (110.57, 96.05; 88.71) and (110.88, 96.77; 88.96) in the first and second season, respectively. Data in Table (4) Illustrate the effect of three irrigation systems SSD: Sub-surface drip, SD: Surface drip, SP: Sprinkler, SW: Saline Water IS: Irrigation Systems and LSD: Less significant differences on Leaf area for three Cultivars (Giza 111, Crawford and Giza 35) in the first and second seasons 2015 and 2016, respectively. Regarding irrigation systems, means values of Leaf area It could be ranking in the following ascending orders: SP < SD < SSD. According to Leaf area, the effect of irrigation systems on Leaf area**,** there is significant differences at the 5 % level between all values of characters.

Regarding to irrigation systems, gradually increases were detected by using irrigation systems, where application of SSD under three cultivars (Giza 111, Crawford and Giza 35) achieved the maximum Leaf area (110.57, 96.05; 88.71) and (110.88, 96.77; 88.96) in the first and second season, respectively.

Table (4) shown that the high Leaf area of cultivar Giza111 significantly exceeded at 5 % level. The rest cultivars (Crawford and Giza 35) were it gave the Leaf area**,** (96.05, 88.71; 96.77, 88.96) in first and second seasons, respectively. The interaction between three saline water levels, three irrigation systems and soybean cultivars had significant effect on Leaf area and the maximum and minimum values of Leaf area (104.82 and 64.70) were obtained by Giza 111 and Giza 35 in the second and first season, respectively.

Leaf area index (LAI).

Data in Table (5) Illustrate the effect of three saline water levels (400ppm, 1200ppm and 2000ppm ppm) on Leaf area index (LAI) for three Cultivars (Giza 111, Crawford and Giza 35) in the first and second seasons 2015 and 2016, respectively.

Regarding saline water levels, means values of LAI, It could be ranking in the following ascending orders: 2000ppm < 1200ppm < 400ppm. According to LAI, the effect of saline water levels on LAI, there is significant differences at the 5 % level between all values of characters.

Regarding to saline water levels, gradually increases were detected by increasing saline water levels, where application of 400ppm ppm under three cultivars (Giza 111, Crawford and Giza 35) achieved the maximum LAI (9.49, 7.78; 7.43) and (9.64, 8.05; 7.67) in the first and second season, respectively. Data in Table (5) Illustrate the effect of three irrigation systems SSD: Sub-surface drip, SD: Surface drip, SP: Sprinkler, SW: Saline Water IS: Irrigation Systems and LSD: Less significant differences on LAI for three Cultivars (Giza 111, Crawford and Giza 35) in the first and second seasons 2015 and 2016, respectively. Regarding irrigation systems, means values of LAI, It could be ranking in the following ascending orders: SP < SD < SSD. According to LAI, the effect of irrigation systems on LAI, there is significant differences at the 5 % level between all values of characters.

Regarding to irrigation systems, gradually increases were detected by using irrigation systems, where application of SSD under three cultivars (Giza 111, Crawford and Giza 35) achieved the maximum LAI (9.49, 7.78; 7.43) and (9.64, 8.05; 7.67) in the first and second season, respectively. Table (5) shown that the high LAI of cultivar Giza111 significantly exceeded at 5 % level. The rest cultivars (Crawford and Giza 35) were it gave the LAI (7.78, 7.43; 8.05, 7.67) in first and second seasons, respectively. The interaction between three saline water levels, three irrigation systems and soybean cultivars had significant effect on LAI and the maximum and minimum values of LAI (8.49 and 4.46) were obtained by Giza 111 and Giza 35 in the second and first season, respectively.

Crop growth rate (CGR)

Data in Table (6) Illustrate the effect of three saline water levels (400ppm, 1200ppm and 2000 ppm ppm) on Crop growth rate (CGR) for three Cultivars (Giza 111, Crawford and Giza 35) in the first and second seasons 2015 and 2016, respectively.

Regarding saline water levels, means values of CGR, it could be ranking in the following ascending orders: 2000ppm < 1200ppm < 400ppm. According to CGR, the effect of saline water levels on CGR, there is significant differences at the 5 % level between all values of characters.

Regarding to saline water levels, gradually increases were detected by increasing saline water levels, where application of 400ppm ppm under three cultivars (Giza 111, Crawford and Giza 35) achieved the maximum CGR (1.57, 1.24; 1.09) and (1.63, 1.36; 1.17) in the first and second season, respectively. Data in Table (6) Illustrate the effect of three irrigation systems SSD: Sub-surface drip, SD: Surface drip, SP: Sprinkler, SW: Saline Water IS: Irrigation Systems and LSD: Less significant differences on CGR for three Cultivars (Giza 111, Crawford and Giza 35) in the first and second seasons 2015 and 2016, respectively.

Regarding irrigation systems, means values of CGR, It could be ranking in the following ascending orders: SP < SD < SSD. According to CGR, the effect of irrigation systems on CGR, there is significant differences at the 5 % level between all values of characters.

Regarding to irrigation systems, gradually increases were detected by using irrigation systems, where application of SSD under three cultivars (Giza 111, Crawford and Giza 35) achieved the maximum CGR, (1.57, 1.24; 1.09) and (1.63, 1.36; 1.17) in the first and second season, respectively.

Table (6) shown that the high CGR of cultivar Giza111 significantly exceeded at 5 % level. The rest cultivars (Crawford and Giza 35) were it gave the CGR, (1.24, 1.09; 1.36, 1.17) in first and second seasons, respectively.

The interaction between three saline water levels, three irrigation systems and soybean cultivars had significant effect on CGR and the maximum and minimum values of CGR (1.22 and 0.36) were obtained by Giza 111 and Giza 35 in the second and first season, respectively.

Net Assimilation Rate (NAR)

Data in Table (7) Illustrate the effect of three saline water levels (400ppm, 1200ppm and 2000ppm ppm) on Net Assimilation Rate NAR for three Cultivars (Giza 111, Crawford and Giza 35) in the first and second seasons 2015 and 2016, respectively

Regarding saline water levels, means values of NAR, it could be ranking in the following ascending orders: 2000ppm < 1200ppm < 400ppm. According to NAR, the effect of saline water levels on NAR, there is significant differences at the 5 % level between all values of characters.

Regarding to saline water levels, gradually increases were detected by increasing saline water levels, where application of 400ppm ppm under three cultivars (Giza 111, Crawford and Giza 35) achieved the maximum NAR (0.165, 0.167; 0.146) and (0.169, 0.169; 0.153) in the first and second season, respectively.

Data in Table (7) Illustrate the effect of three irrigation systems SSD: Sub-surface drip, SD: Surface drip, SP: Sprinkler, SW: Saline Water IS: Irrigation Systems and LSD: Less significant differences on NAR for three Cultivars (Giza 111, Crawford and Giza 35) in the first and second seasons 2015 and 2016, respectively.

Regarding irrigation systems, means values of NAR ,It could be ranking in the following ascending orders: SP < SD < SSD.

According to NAR, the effect of irrigation systems on NAR, there is significant differences at the 5 % level between all values of characters.

Regarding to irrigation systems, gradually increases were detected by using irrigation systems, where application of SSD under three cultivars (Giza 111, Crawford and Giza 35) achieved the maximum NAR, (0.165, 0.167; 0.146) and (0.169, 0.169; 0.153) in the first and second season, respectively.

Table (7) shown that the high NAR of cultivar Giza111 significantly exceeded at 5 % level. The rest cultivars (Crawford and Giza 35) were it gave the NAR, (0.167, 0.146; 0.169, 0.153) in first and second seasons, respectively.

The interaction between three saline water levels, three irrigation systems and soybean cultivars had significant effect on NAR and the maximum and minimum values of NAR (0.16 and 0.07) were obtained by Giza 111 and Giza 35 in the second and first season, respectively.

Relative Growth Rate (RGR)

Data in Table (8) Illustrate the effect of three saline water levels (400ppm, 1200ppm and 2000ppm ppm) on Net Assimilation Rate (RGR) for three Cultivars (Giza 111, Crawford and Giza 35) in the first and second seasons 2015 and 2016, respectively.

Regarding saline water levels, means values of RGR, it could be ranking in the following ascending orders: 2000ppm < 1200ppm < 400ppm.

According to RGR, the effect of saline water levels on RGR, there is significant differences at the 5 % level between all values of characters.

Regarding to saline water levels, gradually increases were detected by increasing saline water levels, where application of 400ppm ppm under three cultivars (Giza 111, Crawford and Giza 35) achieved the maximum RGR (0.021, 0.022; 0.018) and (0.019, 0.024; 0.018) in the first and second season, respectively.

Data in Table (8) Illustrate the effect of three irrigation systems SSD: Sub-surface drip, SD: Surface drip, SP: Sprinkler, SW: Saline Water IS: Irrigation Systems and LSD: Less significant differences on RGR for three Cultivars (Giza 111, Crawford and Giza 35) in the first and second seasons 2015 and 2016, respectively.

Regarding irrigation systems, means values of RGR, it could be ranking in the following ascending orders: SP < SD < SSD.

According to RGR, the effect of irrigation systems on RGR, there is significant differences at the 5 % level between all values of characters.

Regarding to irrigation systems, gradually increases were detected by using irrigation systems, where application of SSD under three cultivars (Giza 111, Crawford and Giza 35) achieved the maximum RGR, (0.021, 0.022; 0.018) and (0.019, 0.024; 0.018) in the first and second season, respectively. Table (8) shown that the high RGR of cultivar Giza111 significantly exceeded at 5 % level. The rest cultivars (Crawford and Giza 35) were it gave the RGR, (0.022, 0.018; 0.024, 0.018) in first and second seasons, respectively.

The interaction between three saline water levels, three irrigation systems and soybean cultivars had significant effect on RGR and the maximum and minimum values of RGR (0.05 and 0.01) were obtained by Giza 111 and Giza 35 in the second and first season, respectively.

Soybean grain yield (Kg/fed)

Data in Table (9) Illustrate the effect of three saline water levels (400ppm, 1200ppm and 2000 ppm) on Grain yield for three Cultivars (Giza 111, Crawford and Giza 35) in the first and second seasons 2015 and 2016, respectively. Regarding saline water levels, means values of Grain yield, It could be ranking in the following ascending orders: 2000ppm < 1200ppm < 400ppm. According to Grain yield, the effect of saline water levels on Grain yield, there is significant differences at the 5 % level between all values of characters.

Regarding to saline water levels, gradually increases were detected by increasing saline water levels, where application of 400ppm ppm under three cultivars (Giza 111, Crawford and Giza 35) achieved the maximum Grain yield (1406, 1199; 1158) and (1510, 1248; 1211) in the first and second season, respectively. Data in Table (9) Illustrate the effect of three irrigation systems SSD: Sub-surface drip, SD: Surface drip, SP: Sprinkler, SW: Saline Water IS: Irrigation Systems and LSD: Less significant differences on Grain yield for three Cultivars (Giza 111, Crawford and Giza 35) in the first and second seasons 2015 and 2016, respectively. Regarding irrigation systems, means values of Grain yield, it could be ranking in the following ascending orders: SP < SD < SSD. According to Grain yield, the effect of irrigation systems on Grain yield, there is significant differences at the 5% level between all values of characters. Regarding to irrigation systems, gradually increases were detected by using irrigation systems, where application of SSD under three cultivars (Giza 111, Crawford and Giza 35) achieved the maximum Grain yield, (1406, 1199; 1158) and (1510, 1248; 1211) in the first and second season, respectively.

Table (9) shown that the high Grain yield of cultivar Giza111 significantly exceeded at 5 % level. The rest cultivars (Crawford and Giza 35) were it gave the Grain yield**,** (1199, 1158; 1248, 1211) in first and second seasons, respectively. The interaction between three saline water levels, three irrigation systems and soybean cultivars had significant effect on Grain yield and the maximum and minimum values of Grain yield (1175 and 467) were obtained by Giza 111 and Giza 35 in the second and first season, respectively.

Table 4 : Effect of saline water and irrigation systems treatments on leaf area of soybean (during 2015 and 2016 seasons).

Saline water	Irrigation system	Soybean cultivars (2015)			Soybean cultivars (2016)		
		Giza 111	Crawford	Giza 35	Giza 111	Crawford	Giza 35
400ppm	SSD	110.57	96.05	88.71	110.88	96.77	88.96
	SD	105.72	91.71	81.06	105.98	91.92	81.46
	Sp	99.07	88.57	74.72	99.55	88.88	74.92
1200ppm	SSD	105.2	90.05	70.13	105.44	90.45	70.43
	SD	101.45	85.7	65.89	101.77	85.9	66.1
	Sp	99.08	79.72	61.24	99.56	80.1	61.52
2000ppm	SSD	95.89	83.97	68.92	96.22	84.2	69.1
	SD	89.4	80.1	64.56	89.66	80.34	64.77
	Sp	83.35	57.7	59.39	83.87	57.85	59.66
LSD 0.05		0.01	0.36	1.23	0.01	0.24	1.83
SW	400ppm	105.12a	92.11a	81.50a	105.47a	92.52a	81.78a
	1200ppm	101.91b	85.16b	65.75b	102.26b	85.48b	66.02b
	2000ppm	89.55c	73.92c	64.29c	89.92c	74.13c	64.51c
LSD 0.05		12.32	6.88	1.22	3.22	6.33	2.11
IS	SSD	103.89a	90.02a	75.92a	104.18a	90.47a	76.16a
	SD	98.86b	85.84b	70.50b	99.14b	86.05b	70.78b
	SP	93.83c	75.33c	65.12c	94.33c	75.61c	65.37c
LSD 0.05		4.94	4.33	4.76	4.66	4.88	4.21
SW x IS x Cultivar		104.51a	91.06a	78.71a	104.82a	91.49a	78.97a
		100.38b	85.50b	68.12b	100.70b	85.76b	68.40b
		91.69c	74.62c	64.70c	92.12c	74.87c	64.94c
LSD 0.05		5.76	9.77	3.76	3.66	4.87	3.85

Where: SSD: Sub-surface drip, SD: Surface drip, SP: Sprinkler, SW: Saline Water IS: Irrigation Systems and LSD: Less significant differences.

Table 5 : Effect of saline water and irrigation systems treatments on leaf area index (LAI) of soybean cultivars (during 2015 and 2016 seasons).

Saline water (ppm)	Irrigation system	Soybean cultivars (2015)			Soybean cultivars (2016)		
		Giza 111	Crawford	Giza 35	Giza 111	Crawford	Giza 35
400ppm	SSD	9.49	7.78	7.43	9.64	8.05	7.67
	SD	8.56	7.00	6.26	8.33	7.21	6.49
	Sp	7.77	6.13	5.25	8.04	6.31	5.46
1200ppm	SSD	8.39	6.63	5.55	8.15	7.25	5.66
	SD	7.55	6.20	5.04	7.83	6.34	5.18
	Sp	7.12	5.23	4.11	7.34	5.45	4.23
2000ppm	SSD	6.88	5.93	5.06	7.15	6.13	5.27
	SD	5.98	5.00	4.55	6.20	5.23	4.69
	Sp	5.32	3.46	3.91	5.55	3.63	4.02
LSD 0.05		0.39	0.41	0.01	0.09	0.02	0.07
SW	400ppm	8.61a	6.97a	6.31a	8.67a	7.19a	6.54a
	1200ppm	7.69b	6.02b	4.90b	7.77b	6.35b	5.02b
	2000ppm	6.06c	4.80c	4.51c	6.30c	5.00c	4.66c
LSD 0.05		0.88	0.94	0.38	0.98	0.84	0.34
IS	SSD	8.25a	6.78a	6.01a	8.31a	7.14a	6.20a
	SD	7.36b	6.07b	5.28b	7.45b	6.26b	5.45b
	SP	6.74c	4.94c	4.42c	6.98c	5.13c	4.57c
LSD 0.05		0.59	0.68	0.70	0.45	0.98	0.86
SW x IS x cultivar		8.43a	6.87a	6.16a	8.49a	7.16a	6.37a
		7.52b	6.04b	5.09b	7.61b	6.31b	5.23b
		6.40c	4.87c	4.46c	6.64c	5.06c	4.61c
LSD 0.05		0.86	0.82	0.58	0.94	0.84	0.61

Where: SSD: Sub-surface drip, SD: Surface drip, SP: Sprinkler, SW: Saline Water IS: Irrigation Systems and LSD: Less significant differences

Table 6 : Effect of saline water and irrigation systems treatments on Crop growth rate (CGR)of soybean cultivars (during 2015 and 2016 seasons).

Saline water	Irrigation system	Soybean cultivars (2015)			Soybean cultivars (2016)		
		Giza 111	Crawford	Giza 35	Giza 111	Crawford	Giza 35
400ppm	SSD	1.574	1.246	1.090	1.633	1.366	1.178
	SD	1.246	1.14	0.728	1.379	1.264	0.809
	Sp	1.161	0.997	0.666	1.254	1.035	0.777
1200ppm	SSD	0.929	0.885	0.712	0.968	0.921	0.798
	SD	0.871	0.565	0.442	0.905	0.593	0.642
	Sp	0.589	0.452	0.417	0.871	0.535	0.451
2000ppm	SSD	0.376	0.699	0.404	0.468	0.811	0.686
	SD	0.315	0.388	0.292	0.347	0.418	0.504
	Sp	0.303	0.297	0.209	0.311	0.351	0.377
LSD 0.05		0.01	0.07	0.06	0.03	0.01	0.02
SW	400ppm	1.33a	1.13a	0.83a	1.42a	1.22a	0.92a
	1200ppm	0.80b	0.63b	0.52b	0.91b	0.68b	0.63b
	2000ppm	0.33c	0.46c	0.30c	0.38c	0.53c	0.52c
LSD 0.05		0.40	0.20	0.20	0.30	0.14	0.10
IS	SSD	0.96a	0.94a	0.74a	1.02a	1.03a	0.89a
	SD	0.81b	0.70b	0.49b	0.88b	0.76b	0.65b
	SP	0.68c	0.58c	0.43c	0.81c	0.64c	0.54c
LSD 0.05		0.14	0.21	0.05	0.06	0.11	0.10
SW x IS x Cultivar		1.14a	1.03a	0.78a	1.22a	1.12a	0.91a
		0.80b	0.66b	0.51b	0.89b	0.72b	0.64b
		0.51c	0.52c	0.36c	0.59c	0.58c	0.53c
LSD 0.05		0.28	0.13	0.14	0.27	0.13	0.10

Where: SSD: Sub-surface drip, SD: Surface drip, SP: Sprinkler, SW: Saline Water IS: Irrigation Systems and LSD: Less significant differences

Table 7 : Effect of saline water and irrigation systems treatments on Net Assimilation Rate (NAR) of soybean cultivars (during 2015 and 2016).

Saline water	Irrigation system	Soybean cultivars (2015)			Soybean cultivars (2016)		
		Giza 111	**Crawford**	**Giza 35**	**Giza 111**	**Crawford**	**Giza 35**
400ppm	SSD	0.165	0.167	0.146	0.169	0.169	0.153
	SD	0.145	0.162	0.126	0.165	0.175	0.124
	Sp	0.207	0.161	0.116	0.155	0.164	0.124
1200ppm	SSD	0.116	0.133	0.126	0.118	0.127	0.140
	SD	0.115	0.091	0.087	0.115	0.093	0.123
	Sp	0.082	0.086	0.01	0.118	0.093	0.106
2000ppm	SSD	0.054	0.117	0.079	0.065	0.123	0.130
	SD	0.052	0.087	0.064	0.055	0.079	0.107
	Sp	0.056	0.085	0.053	0.055	0.069	0.093
LSD 0.05		0.002	0.001	0.010	0.010	0.011	0.011
SW	400ppm	0.17a	0.16	0.13a	0.16a	0.17a	0.13
	1200ppm	0.10b	0.10	0.07b	0.12b	0.10b	0.12
	2000ppm	0.05c	0.10	0.07b	0.06c	0.09c	0.11
LSD 0.05		0.05	0.06	0.05	0.03	0.01	0.01
IS	SSD	0.11b	0.14a	0.12a	0.12a	0.14a	0.14a
	SD	0.10c	0.11b	0.09b	0.11b	0.12b	0.12b
	SP	0.12a	0.11b	0.06c	0.11b	0.11c	0.11c
LSD 0.05		0.01	0.02	0.02	0.01	0.01	0.01
SW x IS x Cultivar		0.14a	0.15a	0.13a	0.14a	0.16a	0.14a
		0.10b	0.11b	0.08b	0.12b	0.11b	0.12b
		0.09c	0.11b	0.07c	0.09c	0.10c	0.11c
LSD 0.05		0.01	0.03	0.01	0.01	0.01	0.01

Where: SSD: Sub-surface drip, SD: Surface drip, SP: Sprinkler, SW: Saline Water IS: Irrigation Systems and LSD: Less significant differences

Table 8 : Effect of saline water and irrigation systems treatments on Relative Growth Rate (RGR) of soybean cultivars (during 2015 and 2016 seasons).

Saline water	Irrigation system	Soybean cultivars (2015)			Soybean cultivars (2016)		
		Giza 111	**Crawford**	**Giza 35**	**Giza 111**	**Crawford**	**Giza 35**
400ppm	SSD	0.021	0.022	0.018	0.019	0.024	0.018
	SD	0.018	0.021	0.015	0.021	0.023	0.017
	Sp	0.018	0.018	0.014	0.02	0.022	0.016
1200ppm	SSD	0.017	0.019	0.015	0.014	0.019	0.014
	SD	0.015	0.013	0.011	0.016	0.014	0.013
	Sp	0.014	0.011	0.009	0.016	0.015	0.011
2000ppm	SSD	0.008	0.017	0.01	0.009	0.018	0.014
	SD	0.006	0.009	0.009	0.008	0.012	0.015
	Sp	0.005	0.009	0.007	0.008	0.011	0.014
LSD 0.05		0.001	0.002	0.001	0.001	0.001	0.001
SW	400ppm	0.02a	0.02a	0.02a	0.02a	0.02a	0.04a
	1200ppm	0.02a	0.01b	0.01b	0.02a	0.02b	0.01b
	2000ppm	0.01b	0.01b	0.01b	0.01b	0.01c	0.01b
LSD 0.05		0.01	0.01	0.01	0.01	0.01	0.02
IS	SSD	0.02a	0.02a	0.015a	0.01b	0.02a	0.02b
	SD	0.01b	0.01b	0.01b	0.02a	0.016a	0.04a
	SP	0.01b	0.01b	0.01b	0.01b	0.016a	0.01c
LSD 0.05		0.01	0.01	0.01	0.01	0.01	0.01
SW x IS x Cultivar		0.02a	0.02a	0.02a	0.02a	0.01a	0.03a
		0.01b	0.01b	0.01b	0.02a	0.01b	0.02b
		0.01b	0.01b	0.01b	0.01b	0.05c	0.01c
LSD 0.05		0.01	0.01	0.01	0.01	0.03	0.01

Where: SSD: Sub-surface drip, SD: Surface drip, SP: Sprinkler, SW: Saline Water IS: Irrigation Systems and LSD: Less significant differences

Table 9 : Effect of saline water and irrigation systems treatments on Grain yield (Kg/fed) of soybean cultivars (during 2014/2015 and 2015/2016 seasons).

Saline water	Irrigation system	Soybean cultivars)			Soybean cultivars (2016)		
		Giza 111	Crawford	Giza 35	Giza 111	Crawford	Giza 35
400ppm	SSD	1406	1199	1158	1510	1248	1211
	SD	1182	995	803	1211	1032	846
	Sp	1186	1053	940	1216	1092	1002
1200ppm	SSD	953	848	804	985	886	837
	SD	813	610	510	847	641	546
	Sp	692	560	530	742	594	556
2000ppm	SSD	587	640	531	622	674	557
	SD	483	452	325	505	475	344
	Sp	474	401	240	505	424	260
LSD 0.05		4	40	30	4	30	1
SW	400ppm	1258.00	1082.33	967.00	1312.3	1124.0	1019.6
	1200ppm	819.33	672.67	614.67	858.00	707.00	646.33
	2000ppm	514.67	497.67	365.33	544.00	524.33	387.00
LSD 0.05		300	170	245	285	180	255
IS	SSD	982.00	895.67	831.00	1039.0	936.00	868.33
	SD	826.00	685.67	546.00	854.33	716.00	578.60
	SP	784.00	671.33	570.00	821.00	703.33	606.00
LSD 0.05		39	13	35	32	12	26
SW x IS x Cultivar		1120	989	899	1175	1030	944
		822	679	580	856	711	611
		649	585	467	682	613	496
LSD 0.05		170	93	110	160	90	110

Where: SSD: Sub-surface drip, SD: Surface drip, SP: Sprinkler, SW: Saline Water IS: Irrigation Systems and LSD: Less significant differences

Discussion

The obtained data of the effect of treated saline water, irrigation systems and soybean crop cultivars on leaf area, leaf area index, crop growth rate (CGR), Net Assimilation Rate (NAR) and Relative Growth Rate (RGR) were better by using Giza 111 and Crawford soybean cultivars, this is due to the increase in the rate of photosynthesis and thus increase the area of leaves of soybean plants for Giza 111 and Crawford soybean cultivars under subsurface drip irrigation system and the use of saline water from 400 to 1200 ppm.

The obtained data of the effect of treated saline water, irrigation systems and soybean crop cultivars on Grain yield (Kg/fed) were better by using Giza 111 and Crawford soybean cultivars, this is due to the increase in the rate of photosynthesis and thus increase the area of leaves of soybean plants for Giza 111 and Crawford soybean cultivars under subsurface drip irrigation system and the use of saline water from 400 to 1200 ppm, these data agreed with Hema *et al*. (2003), Saied *et al*. (2005), Kao *et al*. (2006), Katerji *et al*. (2000), Sobhanian *et al.* (2010), Zang (2006), Sakr and El-Metwally (2009) Amirjani (2010), (Go´mez-Campo and Prakash 1999; Moate *et al*., 2002; Hirt and Shinozaki, 2004; Athar *et al*., 2009; Dubey, 2005; Arrigoni *et al*., 2000; Mittler, 2002; Ashraf and Foolad, 2000, Al-Hakimi, 2001; Mahmoud and Amira, 2010; Dandan and Shi, 2013; Yang, 2007; Qiu, 2011; Zhou, 2012; Shimin and Guocheng, 2000).

Conclusion

It could be concluded to using from 400 to 1200 ppm saline water and subsurface and surface drip irrigation systems to improving soybean growth characters, crop yield, water crop productivity calibrated by AquaCrop model and improving technology properties of soybean within amino acids and soybean oil quality parameters. As well as in the same cases treatments of saline water and drip irrigation systems had positive effects on soil moisture and salinity distribution.

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