EFFECT OF IRRIGATION SCHEDULING, SOIL MULCHING AND AMENDMENTS ON SOME SOIL PHYSICAL PROPERTIES, SOYBEAN YIELD AND CROP WATER RELATIONS UNDER CALCAREOUS CLAY SOILS

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ABSTRACT

Calcareous soils generally have some problems; poor soil physical and chemical properties, crusting, salinity and low productivity. Optimizing water application by irrigation scheduling increases water use efficiency, growth and yield of crops in addition to water rationalization. The aim of the present work was to study the effect of irrigation scheduling, soil mulching and soil amendments application rates on some physical properties of a clay calcareous soil and soybean production and crop water relations. A field experiment was conducted at Menshat Rabie Village, Itsa District, Fyoum Governorate, Egypt. Three irrigation treatments were applied i.e., I_1 (1.0 of cumulative pan evaporation, C.P.E.), I_2 (0.8 of C.P.E.) and I_3 (0.6 of C.P.E.). Two soil mulching treatments were applied, i.e., without soil mulching and black plastic mulching. The effects of two soil amendments namely poultry manure and agriculture sulfur were also tested. Three levels of each soil amendment were applied: (17.86, 35.71, and 53.57 m^3 ha^{-1} of poultry manure) and (178.57, 357.14 and 535.71 kg ha^{-1} of agricultural sulfur). The experiment included 36 treatments distributed in a split split design with three replicates. Soybean (Glycine max. Giza 111 variety) was grown along two successive seasons (2014 and 2015). Obtained results showed that the applied treatments resulted in significant and considerable effects on the studied soil properties such as, decreases of soil bulk density and increases each of total porosity, available water content, soil hydraulic conductivity values and soybean plant growth and productivity. Applied treatments improved water consumptive use and increased the water use efficiency values of soybean crop. It was concluded the application of irrigation treatment 0.8 of cumulative pan evaporation with the use of poultry manure at the rate 53.57 m^3 ha^{-1} under mulching with black plastic were superior than all other studied treatments and could save about 20% of water requirements of soybean crop grown on a clay calcareous soil.

Key words:

Calcareous soils, scheduling irrigation, mulching, soil amendments, soil properties, soybean, water consumptive, use water use efficiency and net profit.

INTRODUCTION

Calcareous soils are defined as soils containing amounts of calcium carbonate distinctly affect the soil physical and chemical properties related to plant growth, i.e., soil water relations, soil crusting and the availability of plant nutrients. Such soil need correctly water and soil integrated management techniques. Calcareous soils cover over 30% of the earth's land surface mainly in arid and semi-arid areas **(Amanullah, 2017)**. Studies of **Skidmore and Layton (1992)** that the fine particle fraction of the soil plays a very important role in the process of crust formation. Particles smaller than 50-60 µm usually act as "cement agent" between larger particles. Any increase in the fine particle contents of a soil leading to an increase of the crust strength.

Soil moisture control by irrigation scheduling is the key factor to success in farming irrigation particularly in calcareous heavy textured soils. Using Class A Pan evaporation records in scheduling crop irrigation is considered the most applicable in agricultural purposes. **Abdou (2004)** found that the soil bulk density values decreased, as irrigation frequency increased. The pronounced reduction was obtained from irrigation at 1.2 C.P.E., in comparison with irrigation at 0.6 C.P.E. Total porosity values were increased by increasing irrigation frequency from 0.6 to 1.2 C.P.E. **Abdo (2008)** concluded that the saturated hydraulic conductivity values were significantly decreased with increasing irrigation frequency.

Mulching is one of the important agronomic practice in conserving soil moisture and modifying the soil physical environment. **Nkongolo et al. (2011)** found that soil properties i.e., soil temperature, moisture content, bulk density, aggregate stability and nutrient availability have been improved by using black plastic mulch. **Kumar et al. (2014)** found that plant growth and yield are positively influenced by black plastic mulch due to the modification of soil microclimate. Addition of poultry manure at the rate 10 t ha^{-1} significantly decreased soil bulk density (P = 0.05) and increased soil organic matter content, total porosity, water holding pores, fine capillary pores, infiltration rate and hydraulic conductivity values **(Obi and Ebo, 1995)**. Studies of **Inal et al. (2015)** showed that the application of both processed poultry manure and biochar in calcareous soils resulted into decreases in soil pH. **Sonmez et al. (2016)** found that increasing sulfur treatments decreased soil pH from 8.0 to 7.8 but not statistically significant. Soybean crop is one of the most important oil crops and it is very sensitive to soil moisture deficit or over irrigation especially at the vegetative growth stage or flowering and fresh pods formation. **Dubey et al. (1995)** found that irrigation at 0.75 I.W (irrigation water): C.P.E. resulted in the greatest seeds yield 3192 t ha^{-1}. **Kazi et al. (2002)** observed that the soybean maximum plant height, number of branches and pods per plant, seeds index and seeds yield, and oil content percentage were found superior with the application of 6 irrigations followed by 5 irrigations. **Nejad et al. (2006)** found that plants irrigated at 60 mm of C.P.E. produced the greatest yield but the least was associated with plants irrigated at 100 mm of C.P.E. Also, they found that the irrigation treatment 80 mm of C.P.E. resulted in the greatest values of water use efficiency by soybean plants, however the least was that associated with the treatment 40 mm of C.P.E.

The aim of the present work was to study the effect of irrigation treatment included (1.0 of C.P.E.), (0.8 of C.P.E.) and (0.6 of C.P.E.), soil mulching and soil amendments on some soil physical properties, crop water relations soybean yield grown on a calcareous clay soil.

Materials and Methods

Field experiment was conducted at Menshat Rabie Village, Itsa district, Fayoum Governorate, Egypt, 10 km south of Fayoum city. The current studied soil was sorted as alluvial clayey soil and have 24.43% of $CaCO_3$. The main plots represented three different irrigation scheduling treatments: I_1 (1.0 of cumulative pan evaporation, C.P.E.), I_2 (0.8 of C.P.E.) and I_3 (0.6 of C.P.E.). Irrigation treatments were conducted after applying the first irrigation at planting. Area of each main plot was about 545 m^2 pounded with dikes (3 m width), in order to avoid the horizontal water seepage. Each main plot was divided into two sub-main plots mulching with black plastic in comparison with no mulching. Each sub main plot was divided into two sub-sub main plots, one was treated with poultry manure and the other with sulfur. Poultry manure treatments were 17.86, 35.71, and 53.57 m^3 ha^{-1} and agricultural sulfur (S) was applied at the rates 178.57, 357.14 and 535.71 kg ha^{-1} of S. The experiment was conducted along two seasons, i.e., 2014 and 2015. Disturbed and undisturbed soil samples were collected from three depths, 0–15, 15-30 and 30–45 cm before planting and before harvesting at the each season, to determine some soil physical and chemical properties. Initial soil properties are shown in Table (1).

The percentages of $CaCO_3$ were determined within each of the soil mechanical fraction i.e., sand, silt and clay. The percentages of $CaCO_3$ in each fraction are given in Table (2).

Two soil amendments (poultry manure and agricultural sulfur) were applied to soil before planting. Table (3) show some chemical analysis of the studied amendments.

Table (1): Some initial soil physical and chemical properties of the studied soil.

Soil properties	Soil depth (cm)		
	0-15	15-30	30-45
Soil physical properties			
Particle size distribution (%)			
Coarse Sand	9.7	2.3	2.7
Fine Sand	18.5	29.9	37.7
Silt	16.4	17.9	19.9
Clay	55.4	49.9	39.7
Texture classes	Clay	Clay	Clay loam
Bulk density ($Mg\ m^{-3}$)	1.24	1.35	1.41
Particle density ($Mg\ m^{-3}$)	2.64	2.65	2.65
Total Porosity, %	53.03	49.06	46.79
Void ratio	1.13	0.96	0.88
Hydraulic conductivity ($cm\ hr^{-1}$)	0 .11	0 .17	0 .26
Field capacity, % (on weight basis)	43.26	40.43	39.19
Wilting point, % (on weight basis)	23.29	22.75	21.98
Available water, % (on weight basis)	19.97	17.68	17.21
Soil chemical properties			
pH in soil paste	7.62	7.54	7.50
EC_e in soil paste extract (dS/m)	6.37	5.98	5.65
Soluble cations, ($mmol^+\ L^{-1}$)			
Ca^{2+}	15.06	14.74	12.59
Mg^{2+}	12.63	12.22	10.17
Na^+	35.90	32.11	33.06
K^+	0.73	0.75	0.69
Soluble anions, ($mmol^+\ L^{-1}$)			
CO_3^{2-}	0.00	0.00	0.00
HCO_3^-	2.80	2.70	2.50
Cl^-	27.20	25.44	23.85
SO_4^{2-}	34.32	31.68	30.16
$CaCO_3$ equivalent, %	24.43	22.91	19.79
Organic matter, %	1.69	1.14	0.98
CEC, ($c\ mol^+\ kg^{-1}$)	33.64	31.11	26.93
Total nitrogen, %	0.08	0.05	0.04

Table (2): Fractionation of $CaCO_3$ in the experimental field.

Depth (cm)	$CaCO_3$ equivalent (%) within the fraction				Total $CaCO_3$, %
	Coarse sand	Fine sand	Silt	Clay	
0 – 15	1.52	11.72	5.06	6.13	24.43
15 – 30	1.52	13.04	2.84	5.51	22.91
30 – 45	1.42	11.76	2.62	3.99	19.79
$CaCO_3$ fraction% of total $CaCO_3$ content in the soil					
0 – 15	6.22	47.98	20.71	25.09	100
15 – 30	6.63	56.92	12.40	24.05	100
30 – 45	7.18	59.42	13.24	20.16	100

Table (3). Some chemical analysis of the used soil amendments.

Poultry manure	pH (1:2.5 suspension)	EC (dS/m)	Organic carbon %	N %	C/N ratio	P mg kg^{-1}	K mg kg^{-1}	$CaCO_3$ %
	7.62	2.97	42.73	2.12	20.16	850	1480	1.31
Agricultural sulfur	pH (1:1 suspension)	EC (dS/m)	S %	Ca mg kg^{-1}	$CaCO_3$ %			
	4.2	3.8	92	60	----			

Soil moisture constants and bulk density (Mg m^{-3}) values of the effective root zone (45 cm depth), are shown in Table (4).

Table (4). Soil moisture constants and water depth (mm) of the effective root zone of the crop (45 cm depth).

Depth (cm)	Available water (%) on weight basis	Bulk density (Mg m^{-3})	Available water (cm)*	Available water (cm) for 45 cm depth	Available water (mm) for 45 cm depth
0 – 15	15.97	1.21	2.898	7.584	75.84
15 – 30	12.68	1.29	2.453		
30 – 45	10.71	1.39	2.233		

*Available water (cm) $= \frac{A.W}{100} \times \gamma_d \times D$ **(Jensen et al., 1990).**

Determinations, measurements and calculations of soil physical properties were conducted according to the methods and procedures outlined and described by **Klute (1986)**. Soil chemical properties were determined according to **Page et al. (1982).**

Soybean (***Glycine max***. Giza 111 variety) was planted in hills 20 cm apart from each other at the 11th May of the season 2014 and in 20th May in the season 2015. The distance between rows was 60 cm. Soybean plants were harvested was after 120 days from planting in both seasons. All other cultural management practices for grown soybean have been conducted following the recommendations of the Egyptian Ministry of Agriculture. The crop evapotranspiration (ETc) or seasonal consumptive use (CU) was determined by measuring soil moisture content before and after each irrigation using the following equation **(Jensen et al., 1990)**:

$$CU = \frac{\theta_2 - \theta_1}{100} \times \gamma_d \times D$$

Where: **CU** is crop water consumptive use (ETc) in cm, $\boldsymbol{\theta_2}$ is soil moisture percentage after 48 hours of irrigation, $\boldsymbol{\theta_1}$ is soil moisture percentage just before irrigation, $\gamma_{\mathbf{d}}$ is soil dry bulk density (Mg m^{-3}), and **D** is soil layer depth in cm.

Seeds yield of soybean (kg ha^{-1}) measurement was carried out after harvesting. Monthly mean weather data (**E_{pan}**) for the two seasons 2014 and 2015 were obtained from Itsa meteorological station, Fayoum, Egypt. The reference evapotranspiration values (ET_o, mm/day) were calculated from evaporation pan (E_{pan}, mm/day) using the following equation **(Allen et al., 1998)**: $\mathbf{ET_o = E_{pan} \cdot K_{pan}}$

Where: E_{pan} is evaporation from the Class A pan (mm day^{-1}) and K_{pan} is the pan evaporation coefficient.

To achieve the intervals between irrigations by class A pan evaporation. The daily records of evaporation (mm) were obtained of the Class A pan. Also, the available water content in the effective soil depth (0-45 cm) was calculated of the soil moisture constant and soil bulk density values. The daily records of evaporation multiplied by the assumed effective pan evaporation rates, i.e. 1.0, 0.8 and 0.6 respectively, (irrigation treatments). The daily records cumulated every next day until the sum of cumulative pan evaporation is equal to the available soil moisture (mm) of the root zone depth (45 cm), then the crop irrigated in this day.

The water use efficiency expressed as kg seeds m^{-3} water consumed by soybean plants. The values have been used to evaluate the variation between different treatments in producing maximum yield from water unit consumed by the grown soybean plants. The water use efficiency for the yield were calculated according to **Fessehazion et al. (2011)** as follows:

$$\text{WUE} = \frac{yield\ (kg\ fed-1)}{CU\ (m3\ fed\ -1)}$$

Where: WUE is the water use efficiency (kg m^{-3}), and CU is consumptive use of soybean plants (m^3 fed^{-1}).

Treatments were distributed using a complete randomized blocks (spilt –split plot) design with three replicates the obtained data were statistically analyzed were statistically analyzed using the procedures outlined by **Snedecor and Cochron (1980).** Treatment means were compared using the (LSD) at 0.05 probability level.

Results and Discussions

The used soil has high fine fractions of $CaCO_3$ content at surface layer. Thus, correctly integrated water and soil management practices are useful for the improvement of the clay calcareous soil properties. The obtained values of soil pH for the chosen soil indicate a neutral nature (pH, 7.50 - 7.62). Additionally, the EC_e values of soil ranged between 5.65 to 6.37 dS/m, it can be indicated that the studied soil reveal slightly to moderately salinity stresses. In addition, it is clear that calcium carbonate contents were greater within the medium and fine size fractions. $CaCO_3$% at different soil fractions decreased according to the ascending order; fine sand > clay > silt > coarse sand fraction.

1. Effect of scheduling irrigation, soil mulching and soil amendments applications on some soil physical properties

1.1. Soil dry bulk density

Results in Table (5) indicated that improvements in the average soil dry bulk density values for the three irrigation treatments followed the order I_2 (0.8 of C.P.E.) > I_1 (1.0 of C.P.E.) > I_3 (0.6 of C.P.E.). Within the surface layer (0-15 cm), under the irrigation treatment I_2 (0.8 of C.P.E.) and the greatest applied of poultry manure amendment resulted in with the minimum values of soil dry bulk density (1.22 and 1.21 Mg m^{-3}) that appeared with no mulching and plastic mulching, respectively.

Table (5). Effect of irrigation scheduling, soil mulching, soil amendments and their interactions on soil dry bulk density values (Mg m^{-3}) (average values of two seasons).*

Irrig. treat.	Poultry manure rate	Organic amendment (Poultry manure) No mulching (M_1) Depth (cm)				Black plastic mulching (M_2) Depth (cm)				Agric. sulfur rate	Inorganic amendment (Agricultural sulfur) No mulching (M_1) Depth (cm)				Black plastic mulching (M_2) Depth (cm)			
		0-15	15-30	30-45	Mean	0-15	15-30	30-45	Mean		0-15	15-30	30-45	Mean	0-15	15-30	30-45	Mean
I_1 (1 of C.P.E.)	P_1	1.32	1.44	1.49	**1.42**	1.30	1.38	1.48	**1.39**	S_1	1.37	1.39	1.46	**1.41**	1.36	1.38	1.45	**1.40**
	P_2	1.30	1.39	1.45	**1.38**	1.26	1.34	1.44	**1.35**	S_2	1.35	1.36	1.42	**1.38**	1.33	1.35	1.42	**1.37**
	P_3	1.24	1.35	1.39	**1.33**	1.21	1.32	1.37	**1.30**	S_3	1.31	1.35	1.40	**1.35**	1.31	1.33	1.40	**1.35**
	Mean	**1.29**	**1.39**	**1.44**	**1.37**	**1.26**	**1.35**	**1.43**	**1.34**	**Mean**	**1.34**	**1.37**	**1.43**	**1.38**	**1.33**	**1.35**	**1.42**	**1.37**
I_2 (0.8 of C.P.E.)	P_1	1.27	1.43	1.47	**1.39**	1.26	1.37	1.47	**1.37**	S_1	1.34	1.38	1.41	**1.38**	1.32	1.36	1.44	**1.37**
	P_2	1.25	1.38	1.43	**1.35**	1.23	1.31	1.41	**1.32**	S_2	1.33	1.35	1.39	**1.36**	1.29	1.35	1.40	**1.35**
	P_3	1.22	1.33	1.38	**1.31**	1.21	1.30	1.37	**1.29**	S_3	1.29	1.33	1.38	**1.33**	1.27	1.31	1.38	**1.32**
	Mean	**1.25**	**1.38**	**1.43**	**1.35**	**1.23**	**1.33**	**1.42**	**1.33**	**Mean**	**1.32**	**1.35**	**1.39**	**1.36**	**1.29**	**1.34**	**1.41**	**1.35**
I_3 (0.6 of C.P.E.)	P_1	1.39	1.48	1.51	**1.46**	1.37	1.46	1.50	**1.44**	S_1	1.40	1.43	1.49	**1.44**	1.35	1.43	1.47	**1.42**
	P_2	1.35	1.42	1.47	**1.41**	1.32	1.41	1.45	**1.39**	S_2	1.38	1.40	1.46	**1.41**	1.33	1.38	1.45	**1.39**
	P_3	1.31	1.39	1.43	**1.38**	1.30	1.35	1.42	**1.36**	S_3	1.35	1.37	1.42	**1.38**	1.32	1.34	1.43	**1.36**
	Mean	**1.35**	**1.43**	**1.47**	**1.42**	**1.33**	**1.41**	**1.46**	**1.40**	**Mean**	**1.38**	**1.40**	**1.46**	**1.41**	**1.33**	**1.38**	**1.45**	**1.39**
LSD %	I	M	P	I×M	I×P	P×M	I×P×M				I	M	S	I×M	I×S	S×M	I×S×M	
0-15 m	0.009	0.007	0.006	NS	0.010	NS	NS				0.009	0.005	0.008	0.009	NS	0.009	NS	
15-30 cm	0.010	0.006	0.007	0.010	NS	NS	0.017				0.004	0.005	0.009	NS	NS	NS	NS	
30-45 cm	0.004	0.007	0.013	0.06	NS	NS	NS				0.012	NS	0.008	0.009	NS	NS	NS	

***Each value in this table is an average of 3 replicates. I = Irrigation treatments, P_1 = 17.86 m^3 ha^{-1}, P_2 = 35.71 m^3 ha^{-1}, P_3 = 53.57 m^3 ha^{-1} , S_1 = 178.57 kg ha^{-1}, S_2 = 357.14 kg ha^{-1}, S_3 = 535.71 kg ha^{-1} and C.P.E. = the cumulative pan evaporation (mm day^{-1}).**

Under all irrigation treatment I_2 (0.8 of C.P.E.), increasing poultry manure application rates from P_1 (½ recommended dose) to P_2 (1.0 recommended dose) and P_3 (1½ recommended dose) resulted in to significant decreases in the mean values of the soil dry bulk density by 2.88 and 5.76 % for treatments without mulching, and by 3.65 and 5.84 % for plastic soil mulching, respectively.

The same trend was also observed with the use of the inorganic amendment (agricultural sulfur). The increase of S application rates from S_1 (½ recommended dose) to S_2 (1.0 recommended dose) and S_3 (1½ recommended dose) showed significant decreases in the mean values of soil dry bulk density by 1.45 and 3.62% for no mulching and by 1.46 and 3.65% for plastic mulching, respectively under irrigation treatment 0.8 of C.P.E. This behavior could be attributed to the fact that the organic amendments application resulted in an increase in the bulk volume of the studied soils and consequently decreased soil bulk density. Similar trend was reported by **Aziz-Nagat (2002).**

1.2. Soil total porosity

Results in Table (6) indicated improvements in the average soil total porosity values for the three irrigation treatments followed the order 0.8 of C.P.E. > 1.0 of C.P.E. > 0.6 of C.P.E. This may be due to the air water balance equilibrium at irrigation treatment 0.8 of C.P.E., but the greatest amount of water irrigation 1.0 of C.P.E. resulted in decreasing the soil total porosity values due to rearrangement of soil particles and reorientation of soil pores by the excess applied water (**Lal and Shukla, 2005).** In the surface layer (0-15 cm), under each of irrigation treatment 0.8 of C.P.E. and greatest poultry manure application, the maximum values of soil total porosity were 59.36% for no mulching and 60.94% for plastic mulching treatments.

Table (6). Effect of irrigation scheduling, soil mulching, soil amendments and their interactions on total porosity values (%) (average values of two seasons).*

Irrig. treat.	Poultry manure rate	Organic amendment (Poultry manure)								Agric. sulfur rate	Inorganic amendment (Agricultural sulfur)							
		No mulching (M_1)				Black plastic mulching (M_2)					No mulching (M_1)				Black plastic mulching (M_2)			
		Depth (cm)				Depth (cm)					Depth (cm)				Depth (cm)			
		0-15	15-30	30-45	Mean	0-15	15-30	30-45	Mean		0-15	15-30	30-45	Mean	0-15	15-30	30-45	Mean
I_1 (1 of C.P.E.)	**P_1**	56.37	55.81	52.21	**54.80**	57.07	55.08	53.08	**55.08**	**S_1**	56.37	55.81	52.21	**54.80**	56.77	56.08	53.08	**55.31**
	P_2	57.60	55.58	52.58	**55.25**	58.51	56.73	53.53	**56.26**	**S_2**	56.68	55.30	52.30	**54.76**	57.07	56.94	53.34	**55.78**
	P_3	58.69	56.73	53.23	**56.22**	59.27	57.57	53.67	**56.84**	**S_3**	56.87	56.63	52.54	**55.35**	58.25	57.15	53.55	**56.32**
	Mean	**57.55**	**56.04**	**52.67**	**55.42**	**58.28**	**56.46**	**53.43**	**56.06**	**Mean**	**56.64**	**55.91**	**52.35**	**54.97**	**57.36**	**56.72**	**53.32**	**55.80**
I_2 (0.8 of C.P.E.)	**P_1**	56.79	56.00	52.50	**55.10**	57.58	55.87	53.40	**55.62**	**S_1**	56.79	56.00	52.50	**55.10**	57.58	55.87	53.40	**55.62**
	P_2	58.38	57.82	52.82	**56.34**	59.65	57.89	54.40	**57.31**	**S_2**	56.71	56.43	52.73	**55.29**	57.80	57.61	54.11	**56.51**
	P_3	59.36	58.71	53.71	**57.26**	60.94	58.78	54.78	**58.17**	**S_3**	57.67	56.70	52.90	**55.76**	58.40	58.29	54.29	**56.99**
	Mean	**58.18**	**57.51**	**53.01**	**56.23**	**59.39**	**57.51**	**54.19**	**57.03**	**Mean**	**57.06**	**56.38**	**52.71**	**55.38**	**57.93**	**57.26**	**53.93**	**56.37**
I_3 (0.6 of C.P.E.)	**P_1**	56.51	55.28	52.28	**54.69**	57.48	55.85	53.15	**55.49**	**S_1**	56.51	55.28	52.28	**54.69**	56.68	55.85	53.15	**55.23**
	P_2	57.04	56.29	52.69	**55.34**	58.69	56.46	53.46	**56.20**	**S_2**	56.58	56.13	52.53	**55.08**	56.60	56.05	53.35	**55.33**
	P_3	57.77	57.31	52.91	**56.00**	59.18	57.61	53.61	**56.80**	**S_3**	57.05	56.53	52.88	**55.49**	57.77	57.20	53.50	**56.16**
	Mean	**57.11**	**56.29**	**52.63**	**55.34**	**58.45**	**56.64**	**53.41**	**56.17**	**Mean**	**56.71**	**55.98**	**52.56**	**55.09**	**57.02**	**56.37**	**53.33**	**55.57**
LSD %	I	M	P	I×M	I×P	P×M	I×P×M				I	M	S	I×M	I×S	S×M	I×S×M	
0-15 m	0.004	0.006	0.006	0.010	0.010	0.010	0.018				0.002	0.006	0.009	0.010	0.014	0.010	0.018	
15-30 cm	0.009	0.005	0.005	0.009	0.008	0.009	0.016				0.381	0.233	0.301	0.404	NS	0.404	0.700	
30-45 cm	0.012	0.005	0.008	0.009	0.013	0.009	0.016				0.011	0.007	0.005	0.011	0.008	0.011	0.020	

***Each value in this table is an average of 3 replicates. I = Irrigation treatments, P_1 = 17.86 m^3 ha^{-1}, P_2 = 35.71 m^3 ha^{-1}, P_3 = 53.57 m^3 ha^{-1} , S_1 = 178.57 kg ha^{-1}, S_2 = 357.14 kg ha^{-1}, S_3 = 535.71 kg ha^{-1} and C.P.E. = the cumulative pan evaporation (mm day^{-1}).**

Under irrigation treatment 0.8 of C.P.E., increasing poultry manure application rate from P_1 to P_2 and P_3 resulted in significant increases in the mean values of soil total porosity by 2.25 and 3.92% for no mulching and by 3.04 and 4.58% for plastic mulching, respectively. The same trend was observed with the use of the inorganic amendment (agricultural sulfur) with little differences than poultry manure as the maximum value was 58.4% with sulfur.

1.3. Available water content of soil

Results in Table (7) indicated improvements in the average soil available water content values for the three irrigation treatments following the order I_2 (0.8 of C.P.E.) > I_1 (1.0 of C.P.E.) > I_3 (0.6 of C.P.E.). This could be due to the air water balance and equilibrium at irrigation treatment 0.8 of C.P.E., however the use of treatment 1.0 of C.P.E. resulted into decreases in soil available water content values due to expected rearrangement of soil particles and reorientation of soil pores by the excess applied water (**Lal and Shukla, 2005)**. In the surface soil layer (0-15 cm), under each irrigation treatment 0.8 of C.P.E. and the greatest rate of applied poultry manure, the maximum values of soil available water content were 17.30% for no mulching and 18.82% for plastic mulching treatments. Under irrigation treatment 0.8 of C.P.E., increasing poultry manure application rate from P_1 to P_2 and P_3 resulted in significant increases in the mean values of soil available water content by 11.63 and 23.58% for no mulching and by 16.04 and 24.78% with plastic mulching, respectively.

Similar trends were observed with the use of the inorganic amendment (agricultural sulfur), but the maximum values were 15.45% and 16.10% for no mulching, however the absolute values of decreases in available water (%) were more greater with poultry manure than S applications.

Table (7). Effect of irrigation scheduling, soil mulching, soil amendments and their interactions on available water content values (%) (average values of two seasons).*

Irrig. treat.	Poultry manure rate	Organic amendments (Poultry manure)								Agric. sulfur rate	Inorganic amendment (Agricultural sulfur)							
		No mulching (M_1)				Black plastic mulching (M_2)					No mulching (M_1)				Black plastic mulching (M_2)			
		Depth (cm)				Depth (cm)					Depth (cm)				Depth (cm)			
		0-15	15-30	30-45	Mean	0-15	15-30	30-45	Mean		0-15	15-30	30-45	Mean	0-15	15-30	30-45	Mean
I_1 (1 of C.P.E.)	**P_1**	12.61	11.58	10.83	**11.67**	13.47	12.30	10.60	**12.12**	**S_1**	13.09	12.21	11.01	**12.10**	14.08	12.11	10.81	**12.33**
	P_2	14.52	12.79	11.27	**12.86**	13.47	12.30	10.60	**12.12**	**S_2**	13.21	12.30	11.08	**12.20**	14.28	12.61	10.81	**12.57**
	P_3	15.86	12.84	11.72	**13.47**	17.67	15.12	11.79	**14.86**	**S_3**	13.78	13.58	11.18	**12.85**	15.34	13.10	11.20	**13.21**
	Mean	**14.33**	**12.40**	**11.27**	**12.67**	**14.87**	**13.24**	**11.00**	**13.04**	**Mean**	**13.36**	**12.70**	**11.09**	**12.38**	**14.57**	**12.61**	**10.94**	**12.70**
I_2 (0.8 of C.P.E.)	**P_1**	13.63	13.09	11.21	**12.64**	14.13	11.99	11.29	**12.47**	**S_1**	13.68	13.83	11.67	**13.06**	14.02	13.69	10.59	**12.77**
	P_2	15.38	14.88	12.06	**14.11**	17.07	15.06	11.29	**14.47**	**S_2**	13.97	13.97	11.97	**13.30**	14.21	13.85	10.92	**12.99**
	P_3	17.30	16.48	13.08	**15.62**	18.82	15.64	11.93	**15.46**	**S_3**	15.45	14.34	12.74	**14.18**	16.10	14.63	11.24	**13.99**
	Mean	**15.44**	**14.82**	**12.12**	**14.12**	**16.67**	**14.23**	**11.50**	**14.14**	**Mean**	**14.37**	**14.05**	**12.13**	**13.51**	**14.78**	**14.06**	**10.92**	**13.25**
I_3 (0.6 of C.P.E.)	**P_1**	12.18	11.04	10.74	**11.32**	13.00	12.63	11.03	**12.22**	**S_1**	12.58	11.48	10.63	**11.56**	13.58	11.64	10.21	**11.81**
	P_2	13.23	12.33	11.23	**12.26**	15.01	13.79	11.10	**13.30**	**S_2**	12.77	11.65	10.85	**11.76**	13.71	11.81	10.30	**11.94**
	P_3	15.27	13.52	11.82	**13.54**	15.78	13.79	11.62	**13.73**	**S_3**	13.13	12.47	11.37	**12.32**	13.87	12.70	11.13	**12.57**
	Mean	**13.56**	**12.30**	**11.26**	**12.37**	**14.60**	**13.40**	**11.25**	**13.08**	**Mean**	**12.83**	**11.87**	**10.95**	**11.88**	**13.87**	**12.70**	**11.13**	**12.57**
LSD %	I	M	P	I×M	I×P	P×M	I×P×M				I	M	S	I×M	I×S	S×M	I×S×M	
0-15 m	0.005	0.006	0.008	0.010	0.013	0.010	0.018				0.013	0.005	0.008	0.008	0.015	0.008	0.014	
15-30 cm	0.004	0.002	0.003	0.004	0.005	NS	0.007				0.009	0.004	0.010	0.007	0.018	0.007	0.011	
30-45 cm	0.009	0.007	0.006	0.011	0.010	0.011	0.020				0.008	0.005	0.008	0.009	0.013	0.009	0.016	

***Each value in this table is an average of 3 replicates. I = Irrigation treatments, P_1 = 17.86 m^3 ha^{-1}, P_2 = 35.71 m^3 ha^{-1}, P_3 = 53.57 m^3 ha^{-1} , S_1 = 178.57 kg ha^{-1}, S_2 = 357.14 kg ha^{-1}, S_3 = 535.71 kg ha^{-1} and C.P.E. = the cumulative pan evaporation (mm day^{-1}).**

Data obtained emphases the greater effect of the organic manure on both the total porosity and available ware (%) than that the inorganic amendment (S). Results also indicated the greater effect of soil mulching in comparison with no mulching. **Mulumba and Lal (2008)** demonstrated that mulch rates significantly increased available water capacity by 18 -35%, total porosity by 35 – 46% and soil moisture retention at low suctions from 29 to 70% under silty loam soil.

1.4. Soil hydraulic conductivity.

Results in Table (8) indicated improvements in the average soil hydraulic conductivity values under the three irrigation treatments as the following order, I_2 (0.8 of C.P.E.) > I_1 (1.0 of C.P.E.) > I_3 (0.6 of C.P.E.). In surface soil layer (0-15 cm), under each of irrigation treatment 0.8 of C.P.E. and greatest rate of applied poultry manure, the maximum values of soil hydraulic conductivity were 0.35 cm hr^{-1} for no mulching and 0.41 cm hr^{-1} for plastic mulching treatments. On the other hand, the irrigation treatment 0.8 of C.P.E. resulted in significant increases in the mean values at surface layer (0-15 cm) of the soil hydraulic conductivity by 10.34% for no mulching and by 13.33% for plastic mulching compared with irrigation treatment 1.0 of C.P.E. Under irrigation treatment 0.8 of C.P.E., increasing poultry manure application rate from P_1 to P_2 and P_3 resulted in significant decreases in the mean values of soil hydraulic conductivity by 4.54 and 11.36% for no mulching and by 4.44 and 15.56% for plastic mulching, respectively. Similar trends were observed with the use of the inorganic amendment (S), but the maximum values were 0.29 cm hr^{-1} and 0.31 cm hr^{-1} for no mulching, however the absolute values of decreases in hydraulic conductivity were more greater with poultry manure than S applications. Data obtained emphases the greater effect of the organic manure on hydraulic conductivity (cm hr^{-1}) than that the inorganic amendment (S).

Table (8). Effect of irrigation scheduling, soil mulching, poultry manure and their interactions on soil hydraulic conductivity values (cm hr^{-1}) (average values of two seasons).*

Irrig. treat.	Poultry manure rate	Organic amendments (Poultry manure)								Agric. sulfur rate	Inorganic amendment (Agricultural sulfur)							
		No mulching (M_1)				Black plastic mulching (M_2)					No mulching (M_1)				Black plastic mulching (M_2)			
		Depth (cm)				Depth (cm)					Depth (cm)				Depth (cm)			
		0-15	15-30	30-45	Mean	0-15	15-30	30-45	Mean		0-15	15-30	30-45	Mean	0-15	15-30	30-45	Mean
I_1 (1 of C.P.E.)	P_1	0.25	0.21	0.18	0.21	0.26	0.23	0.19	0.23	S_1	0.21	0.20	0.19	0.20	0.22	0.20	0.19	0.20
	P_2	0.28	0.22	0.20	0.23	0.29	0.23	0.21	0.24	S_2	0.23	0.21	0.19	0.21	0.24	0.22	0.20	0.22
	P_3	0.35	0.23	0.21	0.26	0.36	0.25	0.22	0.28	S_3	0.25	0.22	0.20	0.22	0.26	0.23	0.21	0.23
	Mean	0.29	0.22	0.20	0.24	0.30	0.24	0.21	0.25	Mean	0.23	0.21	0.19	0.21	0.24	0.22	0.20	0.22
I_2 (0.8 of C.P.E.)	P_1	0.28	0.23	0.19	0.23	0.29	0.24	0.20	0.24	S_1	0.22	0.21	0.19	0.21	0.23	0.22	0.20	0.22
	P_2	0.32	0.24	0.20	0.25	0.33	0.26	0.21	0.27	S_2	0.25	0.22	0.20	0.22	0.26	0.23	0.21	0.23
	P_3	0.35	0.25	0.22	0.27	0.41	0.29	0.23	0.31	S_3	0.26	0.23	0.20	0.23	0.28	0.24	0.22	0.25
	Mean	0.32	0.24	0.20	0.25	0.34	0.26	0.21	0.27	Mean	0.24	0.22	0.20	0.22	0.26	0.23	0.21	0.23
I_3 (0.6 of C.P.E.)	P_1	0.21	0.19	0.17	0.19	0.22	0.20	0.18	0.20	S_1	0.20	0.20	0.19	0.20	0.21	0.20	0.19	0.20
	P_2	0.24	0.20	0.18	0.21	0.25	0.21	0.20	0.22	S_2	0.22	0.20	0.19	0.20	0.22	0.21	0.20	0.21
	P_3	0.29	0.22	0.19	0.23	0.31	0.24	0.21	0.25	S_3	0.24	0.22	0.20	0.22	0.25	0.23	0.20	0.23
	Mean	0.25	0.20	0.18	0.21	0.26	0.22	0.20	0.22	Mean	0.22	0.21	0.19	0.21	0.23	0.21	0.20	0.21
LSD %	I	M	P	I×M	I×P	P×M	I×P×M				I	M	S	I×M	I×S	S×M	I×S×M	
0-15 m	0.004	0.005	0.010	0.008	NS	0.008	0.014				0.019	0.005	0.003	NS	0.006	NS	NS	
15-30 cm	0.011	0.005	0.008	NS	NS	0.008	NS				0.004	0.007	0.007	NS	NS	NS	NS	
30-45 cm	0.004	0.008	0.003	NS	NS	NS	NS				0.004	0.004	NS	NS	NS	NS	NS	

***Each value in this table is an average of 3 replicates. I = Irrigation treatments, P_1 = 17.86 m^3 ha^{-1}, P_2 = 35.71 m^3 ha^{-1}, P_3 = 53.57 m^3 ha^{-1} , S_1 = 178.57 kg ha^{-1}, S_2 = 357.14 kg ha^{-1}, S_3 = 535.71 kg ha^{-1} and C.P.E. = the cumulative pan evaporation (mm day^{-1}).**

Results also indicated the greater effect of soil mulching in comparison with no mulching.

Under irrigation 0.8 of C.P.E., increasing agricultural sulfur application rate from S_1 to S_2 and S_3 resulted in significant decreases in the mean values of soil hydraulic conductivity by 4.88 and 9.76% for no mulching and by 4.88 and 12.20% for plastic mulching, respectively. As a result, irrigation treatments, soil mulching and different levels applications of organic amendments have tremendous effects on these pores, which are considered the main contributors to the passage of drained and percolated water through the soil. Thus, it can be stated that the hydraulic conductivity values are affected by soil texture and stability of soil structure, dominance of some cations and management practices. These findings are consistent with those reported by **Farahani-Elham et al. (2018)**.

2. Effect of irrigation scheduling, soil mulching amendments and their interaction on soybean yield.

Data presented in Table (9) showed that, irrigation treatment (0.8 of C.P.E.) with both plastic mulching and poultry manure application at the rate 53.57 m^3 ha^{-1} resulted in the greatest soybean seeds yield of 3200.00 kg ha^{-1} coincided with the highest addition and 1690.48 kg ha^{-1} with the greatest addition of agricultural sulfur (535.71 kg ha^{-1}), as average of the two successive seasons. With poultry manure application rates, the average seeds yield values were increased by 33.34, 9.71 and 36.76% at irrigation treatments 1.0 of C.P.E., 0.8 of C.P.E. and 0.6 of C.P.E., respectively, for plastic mulching compared with no mulching treatments as average for the two successive seasons. With agricultural sulfur application rates, the average of seeds yield values were increased by 15.68, 18.59 and 15.88 % under irrigation treatments 1.0 of C.P.E., 0.8 of C.P.E. and 0.6 of C.P.E., respectively, for plastic mulching compared with no mulched treatments as average for the two successive seasons (2014 and 2015).

Table (9). Effect of irrigation scheduling, soil mulching, soil amendments and their interaction on soybean yield (kg ha^{-1}) (average values of the two seasons 2014 and 2015)*

Irrigation treat.	Organic amendment (poultry manure)			Inorganic amendment (Agric. sulfur)		
	Poultry manure applica. rate	**No mulching (M_1)**	**Plastic mulching (M_2)**	**Agric. sulfur applica. rate**	**No mulching (M_1)**	**Plastic mulching (M_2)**
I_1 (1 of C.P.E.)	**P_1**	1064.29	1790.48	**S_1**	940.48	1004.76
	P_2	1864.29	2376.19	**S_2**	1100.00	1369.05
	P_3	2176.19	2640.48	**S_3**	1409.52	1623.81
	Mean	**1701.67**	**2269.05**	**Mean**	**1150.00**	**1332.62**
I_2 (0.8 of C.P.E.)	**P_1**	2533.33	2721.43	**S_1**	1245.24	1533.33
	P_2	2623.81	3069.05	**S_2**	1559.52	1680.95
	P_3	3038.10	3200.00	**S_3**	1690.48	2116.67
	Mean	**2731.67**	**2996.90**	**Mean**	**1498.33**	**1776.90**
I_3 (0.6 of C.P.E.)	**P_1**	726.19	1016.67	**S_1**	533.33	659.52
	P_2	1073.81	1452.38	**S_2**	700.00	752.38
	P_3	1245.24	1695.24	**S_3**	926.19	1085.71
	Mean	**1015.00**	**1388.10**	**Mean**	**719.76**	**832.62**

LSD at 5%							
Poultry manure	I	M	P	I×M	I×P	P×M	I×P×M
	0.688	0.879	1.440	1.521	2.495	1.521	2.555
Sulfur	I	M	S	I×M	I×S	S×M	I×S×M
	2.245	0.783	1.319	1.357	2.283	1.357	2.352

*** Each value in this table is an average of 3 replicates. I = Irrigation treatments, P_1 = 17.86 m^3 ha^{-1}, P_2 = 35.71 m^3 ha^{-1}, P_3 = 53.57 m^3 ha^{-1} , S_1 = 178.57 kg ha^{-1}, S_2 = 357.14 kg ha^{-1}, S_3 = 535.71 kg ha^{-1} and C.P.E. = the cumulative pan evaporation (mm day^{-1}).**

Obtained results are in agreement with those obtained by (**Li et al., 2013 and Singh et al**., **2017). Nawar (2008)** who found that the greatest value of soybean seeds yield was produced when irrigated every 14 days in comparison with 28 day.

Under poultry manure applications and irrigation treatment 0.8 of C.P.E., increases were obtained in the mean values of soybean seeds yield by 37.70% and 62.84% for no mulching and by 24.29 and 53.68% for plastic mulching. Increases were 23.25% and 51.96% for no mulching and 25.00 and 53.14% with plastic mulching for compared with irrigation treatments 1.0 of C.P.E. and 0.6 of C.P.E., respectively. The increase in yield as a result of the use of mulch treatments compared to the no mulch could be attributed to reduction of water evaporation from soil that conserve more soil moisture. Data in the present work could led to the conclusion that the application irrigation scheduling 0.8 of C.P.E., plastic soil mulching and addition of poultry manure at the rate 53.57 m^3 ha^{-1} was favourable to produce high seeds yield of soybean crop.

3. Water relationships of soybean crop

3.1. Seasonal water consumptive use

Results in Table (10) showed that the greatest values of water consumptive use of soybean plants were 6142.00 and 5792.00 m^3 ha^{-1} and this was recorded with plants that received 53.57 m^3 ha^{-1} of poultry manure and 535.71 kg $ha^{-1}$of sulfur, respectively, under with no mulching and irrigation treatment 1.0 of C.P.E. as average of two successive seasons. Under poultry manure and without mulching treatments, the mean values of seasonal water consumptive use of soybean plants were increased by 2.19%, 2.29% and 1.98% for the irrigation treatments 1.0 of C.P.E., 0.8 of C.P.E. and 0.6 of C.P.E., respectively, compared with plastic mulching treatments. By using agricultural sulfur and with no mulching treatments, the mean values of seasonal water consumptive use of soybean plants were increased by 0.57%, 1.00% and 0.80% with irrigation treatments 1.0 of C.P.E., 0.8 of C.P.E. and 0.6 of C.P.E., respectively, in comparison with plastic soil mulching. The grand mean values of seasonal water consumptive use of soybean plants were decreased by 3.12 and 10.83% with the use of poultry manure and by 1.60 and 9.19% with sulfur under the irrigation treatments 0.8 of C.P.E. and 0.6 of C.P.E., respectively, as compared with irrigation treatments I_1 (1.0 of C.P.E.), for the two

Table (10). Effect of irrigation scheduling, soil mulching, soil amendments and their interaction on seasonal evapotranspiration values (m^3 ha^{-1}) by soybean plants (average values of the two seasons 2014 and 2015)*

Irriga. treat.	Organic amendment (Poultry manure)				Inorganic amendment (Agric. sulfur)			
	Poultry manure applica. rate	**No mulching (M₁)**	**Plastic mulching (M₂)**	**Grand mean**	**Agric. sulfur applica. rate**	**No mulching (M₁)**	**Plastic mulching (M₂)**	**Grand mean**
I_1 (1 of C.P.E.)	P_1	5712.00	5648.00	5680.00	S_1	5630.00	5570.00	5600.00
	P_2	5863.00	5792.00	5827.50	S_2	5684.00	5646.00	5665.00
	P_3	6279.00	6005.00	6142.00	S_3	5792.00	5719.00	5755.50
	Mean	5762.38	5636.43	5699.40	**Mean**	5598.33	5567.38	5582.86
I_2 (0.8 of C.P.E.)	P_1	5686.00	5524.00	5605.00	S_1	5551.00	5515.00	5533.00
	P_2	5757.00	5617.00	5687.00	S_2	5575.00	5550.00	5562.50
	P_3	5844.00	5768.00	5806.00	S_3	5669.00	5637.00	5653.00
	Mean	5951.43	5815.00	5883.21	**Mean**	5701.90	5645.00	5673.45
I_3 (0.6 of C.P.E.)	P_1	5107.00	5049.00	5078.00	S_1	5090.00	5014.00	5052.00
	P_2	5368.00	5173.00	5270.50	S_2	5148.00	5116.00	5132.00
	P_3	5420.00	5358.00	5389.00	S_3	5280.00	5264.00	5272.00
	Mean	5298.33	5193.33	5245.83	**Mean**	5172.67	5131.33	5152.00
LSD at 5% level	I	M	P	I×M		I×P	P×M	I×P×M
	300.31	185.26	NS	NS		NS	NS	NS
	I	M	S	I×M		I×S	S×M	I×S×M
	1.60	1.53	1.32	2.65		2.29	2.65	4.60

*** Each value in this table is an average of 3 replicates. I = Irrigation treatments, P_1 = 17.86 m^3 ha^{-1}, P_2 = 35.71 m^3 ha^{-1}, P_3 = 53.57 m^3 ha^{-1} , S_1 = 178.57 kg ha^{-1}, S_2 = 357.14 kg ha^{-1}, S_3 = 535.71 kg ha^{-1} and C.P.E. = the cumulative pan evaporation (mm day^{-1}).**

successive seasons. Similar trend was observed by **Ji and Unger (2001) and Li et al. (2013).**

3.2. Water use efficiency of soybean crop

Data presented in Table (11) showed that the greatest values of water use efficiency of soybean plants were 0.555 and 0.375 kg m^{-3} when plants received the greatest addition of both poultry manure (P_3) and agricultural sulfur (S_3), respectively under the irrigation treatment 0.8 of C.P.E. and plastic mulching. These results may be rendered to the greatest values of

Table (11). Effect of irrigation scheduling, soil mulching, soil amendments and their interaction on water use efficiency (kg m^{-3}) by soybean plants (average values of two seasons 2014 and 2015)*

Irrig. treat.	Organic amendment (Poultry manure)				Inorganic amendment (Agric. sulfur)			
	Poultry manure applica. rate	**No mulching (M_1)**	**Plastic mulching (M_2)**	**Grand mean**	**Agric. sulfur applica. rate**	**No mulching (M_1)**	**Plastic mulching (M_2)**	**Grand mean**
I_1 (1 of C.P.E.)	**P_1**	0.186	0.317	0.252	**S_1**	0.167	0.180	0.174
	P_2	0.318	0.410	0.364	**S_2**	0.194	0.242	0.218
	P_3	0.347	0.440	0.394	**S_3**	0.243	0.284	0.264
	Mean	**0.284**	**0.389**	**0.337**	**Mean**	**0.201**	**0.235**	**0.218**
I_2 (0.8 of C.P.E.)	**P_1**	0.446	0.493	0.470	**S_1**	0.224	0.278	0.251
	P_2	0.456	0.546	0.501	**S_2**	0.280	0.303	0.292
	P_3	0.520	0.555	0.538	**S_3**	0.289	0.375	0.332
	Mean	**0.474**	**0.531**	**0.503**	**Mean**	**0.246**	**0.319**	**0.283**
I_3 (0.6 of C.P.E.)	**P_1**	0.142	0.201	0.172	**S_1**	0.105	0.132	0.119
	P_2	0.200	0.281	0.241	**S_2**	0.136	0.147	0.142
	P_3	0.230	0.316	0.273	**S_3**	0.175	0.206	0.191
	Mean	**0.191**	**0.266**	**0.229**	**Mean**	**0.139**	**0.162**	**0.151**
LSD at 5% level	I	M	P	I×M	I×P	P×M	I×P×M	
	0.001	0.001	0.001	0.002	0.002	0.002	0.003	
	I	M	S	I×M	I×S	S×M	I×S×M	
	0.066	NS	0.052	NS	NS	NS	NS	

**** Each value in this table is an average of 3 replicates. I = Irrigation treatments, P_1 = 17.86 m^3 ha^{-1}, P_2 = 35.71 m^3 ha^{-1}, P_3 = 53.57 m^3 ha^{-1} , S_1 = 178.57 kg ha^{-1}, S_2 = 357.14 kg ha^{-1}, S_3 = 535.71 kg ha^{-1} and C.P.E. = the cumulative pan evaporation (mm day^{-1}).**

seeds yield of soybean which was obtained with the irrigation treatment 0.8 of C.P.E. compared with the lowest ones associated with 1.0 of C.P.E. and 0.6 of C.P.E. treatments. With poultry manure application and plastic mulching treatments, the mean values of water use efficiency of soybean plants were increased by 26.99%, 10.73% and 28.20% the irrigation treatments 1 of C.P.E., 0.8 of C.P.E. and 0.6 of C.P.E., respectively, compared with no mulching.

Concerning, sulfur application with plastic mulching, the mean values of water use efficiency of soybean plants were increased by 14.47%, 22.88% and 14.20% at irrigation treatments 1.0 of C.P.E., 0.8 of C.P.E. and 0.6 of C.P.E., respectively, compared with no mulching. Grand mean values of water use efficiency of soybean plants were decreased by 33.00 and 54.47% with the use of poultry manure and by 22.97 and 46.64% with agricultural sulfur at irrigation treatments1.0 of C.P.E. and0.6 of C.P.E., respectively, compared with irrigation treatment 0.8 of C.P.E. as average of the two successive seasons (2014 and 2015). Scheduling irrigation at irrigation treatment 1.0 of C.P.E. increased water consumption but decreased water use efficiency **(Dubey et al., 1995)**.

4. Estimated economic income (net profit, L.E.) as affected by irrigation scheduling, soil mulching and soil amendments application rates.

Data in Figure (1) indicated that the greatest addition of the poultry manure (P_3, 535.71 kg ha^{-1}), using plastic soil mulching and irrigation treatment 0.8 of C.P.E. resulted in the greatest value of net profit (12290 L.E.) for soybean seeds. On the other hand, the lowest value of net profit was negative (-245 L.E.) with the use each of agricultural sulfur (S_1, 178.57 kg ha^{-1}), no soil mulching and irrigation treatment 0.6 of C.P.E.

Data in Figure (1) showed that the values of net profit were increased by increasing poultry manure or agricultural sulfur application rates under all irrigation treatments in the studied calcareous clay soil especially at irrigation treatment 0.8 of C.P.E. These results may be due to the effect of organic matter on improving physical and chemical soil characteristics that consequently positively reflected on the growth attributes and seeds yield. On the other hand, Figure (1) showed that with the use of poultry manure with no mulching, the values of net profit of soybean plants were greater at irrigation treatment I_1 and I_3 compared with I_2.

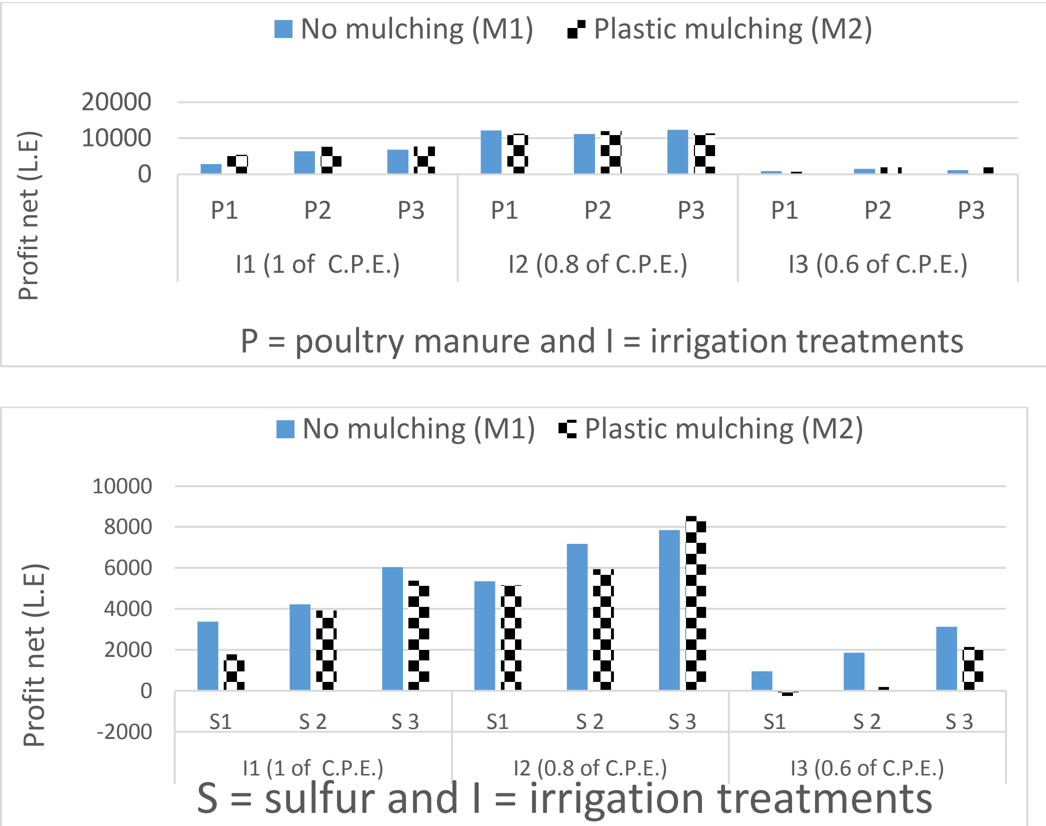

Fig (1). Net profit (L.E.) from soybean crop as influenced by irrigation scheduling, soil mulching and amendments application rates (average values of the two seasons 2014 and 2015).

The mean values of economic income of soybean crop was decreased under poultry manure and soil plastic mulching due the higher price of soil plastic compared with no mulching. The highest values of net profit of soybean crop (8535 L.E.) was recorded at irrigation treatment 0.80 of C.P.E. with plastic mulching under the greatest addition of sulfur treatment (535.71 kg ha^{-1}).

It could be concluded that using each of the irrigation treatment 0.80 of C.P.E., poultry manure at the rate 53.57 m^3 ha^{-1} and black plastic mulching are the most suitable for the production high seed soybean yield. These treatments could save about 20% of water requirements of soybean crop grown in calcareous clay soils under Fayoum Governorate conditions.

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تأثير جدولة الري وتغطية التربة والمصلحات الارضية على بعض خواص التربة الفيزيائية والعلاقات المائية وانتاجية محصول فول الصويا تحت ظروف الأراضي الطينية الجيرية

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تعاني الأراضي الجيرية من بعض المشاكل مثل سوء الخواص الفيزيائية والكيميائية والغذائية والمائية وتكوين القشرة السطحية الصلبة ونقص القدرة الإنتاجية لها، وتزيد هذه المشاكل تحت ظروف قوام التربة الطيني وزيادة ملحية التربة. إجراء الجدولة لمياه الري كنوع من الإدارة المائية الجيدة تزيد من كفاءة استخدام المياه ونمو وإنتاجية المحاصيل بالإضافة الى حدوث ترشيد استخدام مياه الري.

ويهدف هذا البحث الى دراسة تأثير جدولة الري وتغطية سطح التربة وإضافة معدلات مختلفة من المصلحات الأرضية على الخصائص الفيزيائية للتربة الطينية الجيرية وانتاجية فول الصويا والعلاقات المائية له. أقيمت تجربة حقلية بقرية منشاة ربيع التابعة لمركز اطسا محافظة الفيوم - مصر، تم تطبيق ثلاثة معاملات للري هي I_1, I_2 and I_3 حيث تمثل المعاملة I_1 الري عند ١.٠ (١٠٠٪) من البخر التراكمي المحسوب من وعاء البخر القياسي Cumulative pan evaporation (C.P.E.) والمعاملة I_2 الري عند ٠.٨ من (C.P.E.) والمعاملة I_3 الري عند ٠.٦ من (C.P.E.)، وقد تم أيضا دراسة تأثير معاملتين لتغطية سطح التربة الأولى (عدم تغطية سطح التربة) والثانية (تغطية سطح التربة بالبلاستيك

الأسود)، وتم إضافة نوعان من المصلحات الأرضية هما: سماد الدواجن والكبريت الزراعي، وشملت التجربة ثلاثة مستويات من كل مصلح هي: ١٧.٨٦ ، ٣٥.٧١ ، ٥٣.٥٧ م^{٣} / للهكتار من سماد الدواجن و ١٧٨.٥٧ ، ٣٥٧.١٤ ، ٥٣٥.٧١ كجم للهكتار من الكبريت الزراعي، وبذلك تشمل التجربة ٣٦ معاملة موزعة إحصائيا في نظام تصميم القطاعات المنشقة مرتين مع ثلاثة مكررات. تم زراعة نبات فول الصويا ***Glycine max.*** صنف جيزة ١١١ في أرض التجربة تحت الدراسة في موسمين متعاقبين (٢٠١٤ ، ٢٠١٥).

تشير النتائج المتحصل عليها من التجربة الى أن معاملات الري وتغطية سطح التربة وإضافة المصلحات الأرضية أدت الى حدوث تأثيرات معنوية في الصفات الفيزيائية للتربة المدروسة، حيث حدث نقص معنوي في قيم كل من الكثافة الظاهرية الجافة للتربة، وفي الجانب الآخر أدى تطبيق المعاملات سالفة الذكر الى حدوث زيادة معنوية في قيم كل من المسامية الكلية للتربة والماء الميسر بالتربة والتوصيل الهيدروليكي للتربة ونمو وانتاجية محصول فول الصويا. وقد وجد أيضا أن معاملات الري والتغطية واضافة المصلحات الأرضية كان لها تأثيرات معنوية في تحسين قيم الاستهلاك المائي الموسمي وزيادة كفاءة استخدام المياه بواسطة نباتات فول الصويا.

وأوضحت النتائج المتحصل عليها بشكل عام أن ري محصول فول الصويا باستخدام المعاملة: (٠.٨ من البخر التراكمي المحسوب من البخر الناتج من وعاء البخر القياسي) مع إضافة ٣٥.٥٧ م^{٣} للهكتار من سماد الدواجن تحت ظروف تغطية سطح التربة بالبلاستيك الأسود كانت أفضل المعاملات مقارنة بالمعاملات الأخرى تحت الدراسة، وأن اتباع ذلك من الممكن أن يؤدي الى أيضا أدت هذه المعاملات الى توفير حوالي ٢٠٪ من الاحتياجات المائية اللازمة لري نباتات فول الصويا المنزرعة تحت ظروف التربة الطينية الجيرية.