EFFECT OF SOIL CONDITIONERS ON YIELD, WATER PRODUCTIVITY AND SOIL MOISTURE DISTRIBUTION PATTERNS OF CUCUMBER GROWN UNDER SUBSURFACE DRIP IRRIGATION ON A SANDY SOIL

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ABSTRACT

A field experiment was conducted in sandy soil in a private farm, El-Giza, Egypt, throughout two consecutive summer seasons for 2014 and 2015, to assess the impact of soil conditioners on cucumber (Cucmissativus l.) plants under subsurface drip irrigation. The drip lines treatments were (GR; GR anti-root; and T-tape), while the soil conditioners treatments were (Compost; Rice straw; Polymer; and Control). The result showed that the compost with Anti-roots treatment achieved highest yield, where the yield was greater by 20.12%, 34.42% and 57.31% comparing with rice straw, polymers, and control treatments, respectively, for the first season, while it was greater by 16.7 %, 32.7 and 53.8% than rice straw, polymers, and control treatments, respectively, for the second season. The water productivity under compost with GR anti-root treatment was greater by 10.16% and 11.8% comparing with compost with GR and compost with t-tape treatments, respectively, for the first season, while it was greater by 8.34% and 9.5% than compost with GR and compost with t-tape treatments, respectively, for the second season. Data from this study indicate that cucumber yield can be improved under subsurface drip irrigation by using compost and GR anti-root as drip line.

Keywords: *Subsurface drip irrigation, soil conditioners, cucumber, water productivity, soil moisture distribution pattern.*

1. INTRODUCTION

The choice of appropriate irrigation method is the key-factor for irrigation water-saving and increase productivity in arid areas is paramount. In times of drought and water scarcities effective irrigation systems have become more important.

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There are definite difficulties in the sandy soil management, including excessive infiltration rate, low water and nutrient holding capacity (Suganya and Sivasamy, 2006). This system is known for its slow frequent addition of water to the soil through emitters placed along the lateral line under the soil surface (Neufeld et al., 1999).

SDI-system has a high water application efficiency that can contribute significantly to improving the efficiency of water use for crops and water conservation (Hanson and May, 2004). In respect of water losses by evaporation the surface drip irrigation is the most water-saving irrigation system. However, in sandy soils with low water holding capacity, the loss of water and nutrients due to leaching is a serious drawback (Schaumberger and Loiskandl, 2010).

Water scarcity led to use saline water for crop irrigation (Chen et al., 2010). The low quality of irrigation water adversely affects plant growth and crop productivity (Carmassi et al., 2010; Valdez-Aguilar et al., 2013). For instance, under irrigation with saline water, sodium ions (Na^+) will pile up in plant tissues, and then shake the water absorption and reduce the absorption of essential nutrients such as nitrogen (N), phosphorus (P), potassium (K) and calcium (Ca) (Lakhdar et al., 2008). Furthermore, the buildup of sodium leads to a reduction of plant growth (Tejada et al., 2006; Chen et al., 2010). Therefore, it is important to find ways to reduce the negative effects of the water of low quality if used for irrigation purposes.

The application of organic matter as a soil conditioner is a common exercise in areas affected by salts to reduce the negative effects of saline water. The application of OMC has three main valuable effects on plant and soil system: (a) Improving salt leaching through refining soil permeability and structure (Walker and Bernal, 2008; Lakhdar et al., 2011), (b) suppling substantial nutrients for plants (Lakhdar et al., 2008), and (c) reestablishing microbial populations and activities (Lakhdar et al., 2009). Compost application in the salty soils can increase water infiltration, speed up leaching of sodium chloride, lower sodium exchangeable ratio and lower electrical conductivity (Hanson and May, 2004). Natural organic materials include animal dung, crop residues, organic compost, sawdust, food, and remnants of waste and manufacturing papers, all of which are used for soil reclamation to increase infiltration and retention of water, provide the foundation for biological activity, improve aeration, reduce soil strength and pressure resistance, and surface sealing. This is particularly important to improve the growing of crops in sandy soil (Akelah, 2013). Animals manure is known for enhancing plant growth in saline soils. It is also a source of nutrients that can mend soil fertility (Tejada et al., 2006; Walker and Bernal, 2008).

The best practices for the management of sandy soil are routine addition of organic matter, in order to help increase the capacity of sandy soil to retain water and nutrients. Soils that contain high percentages of organic matter (4-5%) are considered ideal for gardens (David et al., 2011). Therefore to improve agricultural productivity and soil fertility it is necessary to add organic matter to the soil. However, because of limited resources of traditional organic materials such as animal manure, the use of other organic wastes such as sewage sludge, agricultural waste and industrial solid waste is growing (Baybordi et al., 2000). Among the organic manures, compost is the most important economical source of nitrogen. The use of chemical fertilizers and pesticides in agricultural ecosystems cause environmental pollution, soil erosion, result in contaminate food chain and result in pest resistance to pesticides. Human and environmental problems, arise the necessitates of non-chemical methods of soil fertilization. Application of organic manure and biological control, represents a vital role in this context (Greer and Diver, 2000).

Applying compost to the soil enhances soil composition and reduces bulk density (Caravaca et al., 2002). Heikal et al. (2008), reported that the affirmative impact of compost on increment of tuber productivity of potato is a true reflection of improving soil water retention due to its effect on pore size distribution i.e., water holding in pores.

Rice straw is the primary output organic waste of rice cultivation. Rice straw is an important source of nutrients (it contains 0.6% nitrogen, 0.1% each of phosphorus and sulfur, 1.5% potassium, 5% silica and 40% carbon). Davies et al. (1993) reported that mulching through utilization of rice straw lead to increased soil moisture content, increase soil nutrients, improve the biological activity of the soil, and increased plant growth and consequently productivity. Esawy et al. (2009) reported that utilization of rice straw as organic manure, may have played an indispensable role not only in enhancing soil physical properties and soil-water holding capacity but also to the improvement of plant nutrients.

Super absorbent polymers (SAP) can raise soil-water capacity for sandy soil (Al-Omrana et al., 2004). El-Gindy et al. (2001) reported that sandy soil has a low ability to retain water and using soil conditioners especially polymers can increase their ability to retain water. The integration of polymer into the soil improves the soil assembly and water holding capacity, thus reducing leakage and consequently reducing water losses due to percolation, saving plant of water stress and increasing both nutrients and water supply to the roots. Zhang et al. (2006) reported that utilization of SAPs can renovate the sandy soil and lower irrigation water consumption, improving the retention of fertilizers in soil, reducing mortality rate of plants, and increased plant growth rate. Akhter et al. (2004) reported that application of soil conditioner with SAR can improve the setting up of plants in water-stressed regions. Superabsorbent compounds have been made through the metal merged with hydrogels to decrease manufacture costs and enhance the salt impedance, including fertilizers in the network of superabsorbent may therefore be an operational way to increase the efficient use of both water and fertilizer compounds (Akelah, 2013).

The objective of this research is to study the effect of using soil conditioners with saline water on cucumber yield, water productivity and soil moisture distribution patterns in sandy soil, this objective was achieved through the following specific aims: a) comparing the effectiveness of soil conditioners on water productivity for cucumber, b) study the effect of soil conditioners with saline water on vegetative growth parameters and yield of cucumber, and c) study the soil moisture distribution patterns in sandy soil.

2. MATERIALS AND METHODS

2.1. Experimental location characteristics

The research was proceeded from April to July 2014 and 2015 at El-Hussein village (private farm), El-Giza, Egypt (latitude 29.97N, and

31.13E longitudes). The soil of the experimental site has a deep soil profile, sandy soil with good drainage.

Mechanical analysis (sand, silt and clay) was determined according to the pipette method as described by Dewis and Fartias (1970). Soil reaction (pH) was measured in 1 : 2.5 (soil: water) suspension according to Jackson (1967). Total water soluble salts were measured by the electrical conductivity meter apparatus in soil paste extract (Richards, 1954). Soluble ions (Na^+, K^+, Ca^{+2}, Mg^{+2}, CO_3^{-2}, HCO^{-3}, SO_4^{-2} and Cl^-) were determined according to Jackson (1967). Organic matter content (%) was determined according to Wally and Black method as described by Hesse (1971). Soil bulk density and the bulk density of the mixture between soil and soil conditioners was determined using cylindrical sharp edged samples. Each cylinder was pressed gently into the soil to the desired depth to obtain a known volume of the undisturbed soil. Samples were oven dried at 105 °C and the bulk density calculated as g/cm^3 (Vomocil, 1957). Field capacity ($\Theta_{\mathbf{FC}}$) and permanent wilting point (Θ_{PWP}) were determined by using pressure membrane method (desorption) at 0.33 and 15 atm, respectively (Klute, 1986).

Table 1 and 2 shows the physical and chemical properties of the soil of the experimental site and applied soil conditioners. The chemical composition of the soil conditioners represents that the compost has the highest organic matter with 22.6%, followed by rice straw with 1.5%, while polymer has no organic matter (Table 3). Irrigation water has been acquired from a deep well (60m depth from the soil surface) positioned at the experimental site, with pH 7.01, and the mean electrical conductivity of 7.06 dS.m^{-1} (Table 4).

2.2. Crop administration

The Cucumber (Prince) variety (*Cucmissativus l.*) was used in field experiments. The cultivation of plants in the three-leaf stage on April 17th in each of the both growing seasons, in a single plot, the plot consists of 3 rows (2.4 m × 15 m). According to that a distance of 80cm between rows and 30cm between plants on the same row were achieved, which gives the plant population of up to 41667 plants per hectare.

Fertilizers were added and mixed with the soil uniformly to all treatments, fertilizers used consists of 60 kgha^{-1} chicken manure, 120 kgha^{-1} actual N (as urea 46% N), 150 $kgha^{-1}$ K_2O, 180 $kgha^{-1}$ P_2O_5, and 300 $kgha^{-1}$ was injected $kgha^{-1}$ N using venturi through subsurface drip irrigation system underneath the soil surface in four equal installments over a period of fruiting (Wang et al., 2009).

Table 1. Soil textural classes, field capacity (θ_{FC}), wilting point (θ_{WP}) wilting point (θ_{WP}), bulk density, pH and electrical conductivity.

Soil depth (cm)	Texture	Θ_{FC} ($cm^3.cm^{-3}$)	Θ_{PWP} ($cm^3.cm^{-3}$)	Bulk density ($g.cm^{-3}$)	pH	ECe ($dS.m^{-1}$)
0 – 20	Sand	10.7	3.1	1.62	7.65	2.16
20 – 40	Sand	12.1	3.5	1.59	8.17	0.78
40 – 60	Sand	11.9	3.5	1.58	8.12	1.01

Table 2. Experimental soil characteristics after mixing with compost, rice straw and polymers.

Soil conditioner	Θ_{FC} ($cm^3.cm^{-3}$)	Θ_{PWP} ($cm^3.cm^{-3}$)	Bulk density ($g.cm^{-3}$)	pH	ECe ($dS.m^{-1}$)
Compost	19.3	6.3	1.65	7.17	2.1
Rice straw	18.9	5.4	1.67	7.49	7.53
polymers	21.3	7	1.64	7.62	4.88

Table 3. Chemical composition of soil conditioners.

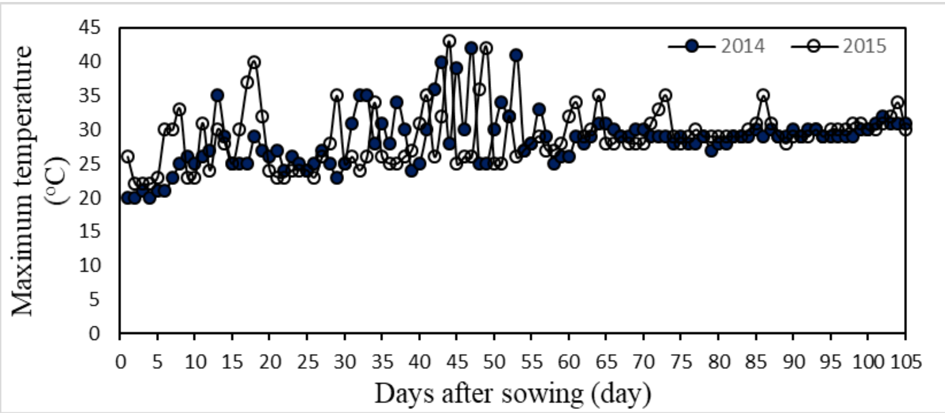
Soil conditioner	N (%)	P (%)	K (%)	Organic matter (%)	C/N
Compost	23.8	18.6	13.3	22.6	0.136
Rice straw	0.629	1.96	0.2	1.5	0.24
Polymers	12.1	0.03	4.6		

Table 4. Irrigation water chemical analysis in experimental site.

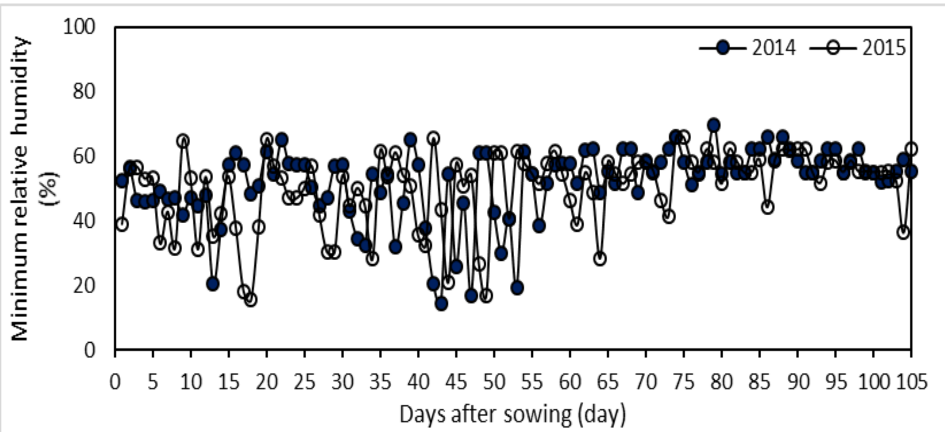
pH	EC ($ds.m^{-1}$)	TDS (ppm)	Soluble cations (meq/l)				Soluble anions (meq/l)				SAR (%)
			Ca^+	Mg^{+2}	Na^+	K^+	Co_3^{-2}	HCO^{-3}	Cl^-	SO_4^{-2}	
7	7.06	4518	18.8	13.2	33	0.25	0.00	2.8	46.6	15.85	8.25

2.3. Climatic conditions

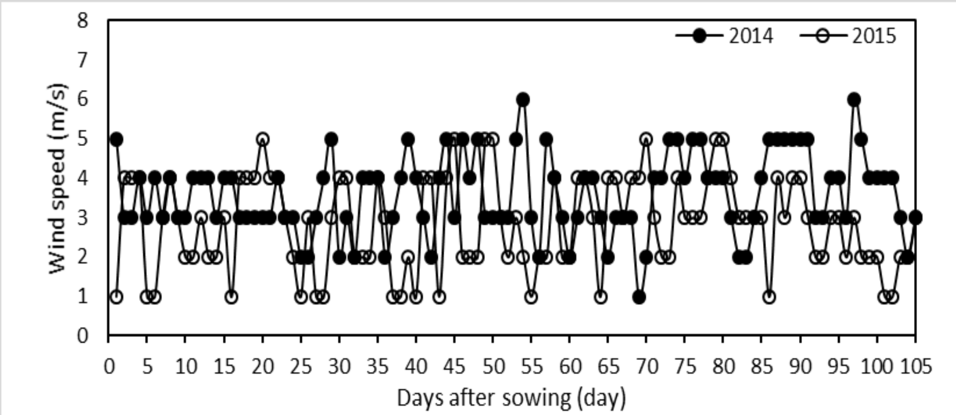
Experimental site has a dry climate with cold winter and hot dry summer. The meteorological variables were recorded every day through each of the both growing seasons (2014 and 2015) and they are as follows: the maximum temperature, dew point temperature, minimum relative humidity and wind speed at which were measured at 2m above ground (Fig. 1). The total collected depth of rain each year (<20 mm). Therefore, the presence of soil water is due almost entirely for irrigation.



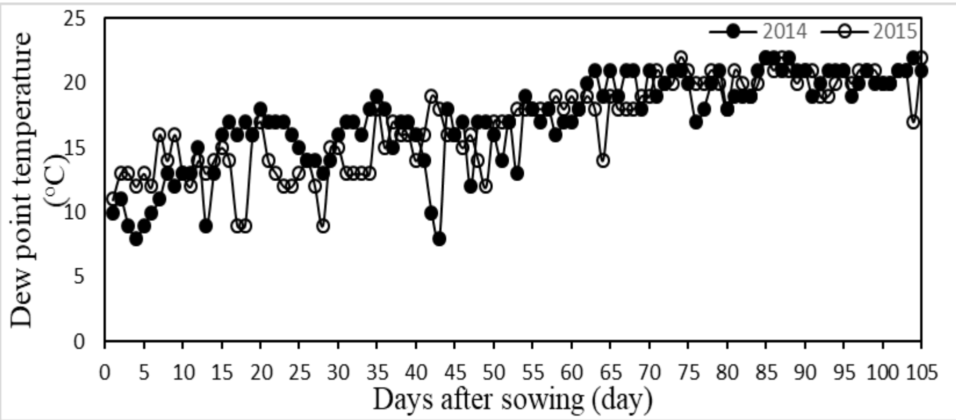
Daily maximum temperature for the two growing seasons



Daily minimum relative humidity for the two growing seasons



Daily wind speed for the two growing seasons



Daily dew point temperature for the two growing seasons

Fig. 1. Daily climatic criteria for both growing seasons of the experimental site.

2.4. The equilibrium of soil-water and crop evapotranspiration

Soil-water equilibrium and crop evapotranspiration (ET_C) were daily calculated with a computer software written a programming language (Microsoft Excel-Based). The input elements of program were daily weather data including; rainfall depth, irrigation dates and quantities, initial soil moisture content in the soil at crop emergence, crop and experimental site characterization, such as the date of planting, maturity, soil parameters (field capacity, wilting point, available water and management allowable depletion during and after initial stage), the maximum depth of the roots. The crop evapotranspiration and soil-water balance in the root zone were daily calculated using the computer program by following the procedures set by the Food and Agriculture Organization 56 (Jose et al., 2008). This procedure calculates the crop evapotranspiration (ET_C) using grass as a reference crop to calculate the reference evapotranspiration (ET_O) and by multiplying it by crop coefficient (K_C) to obtain (ET_C).

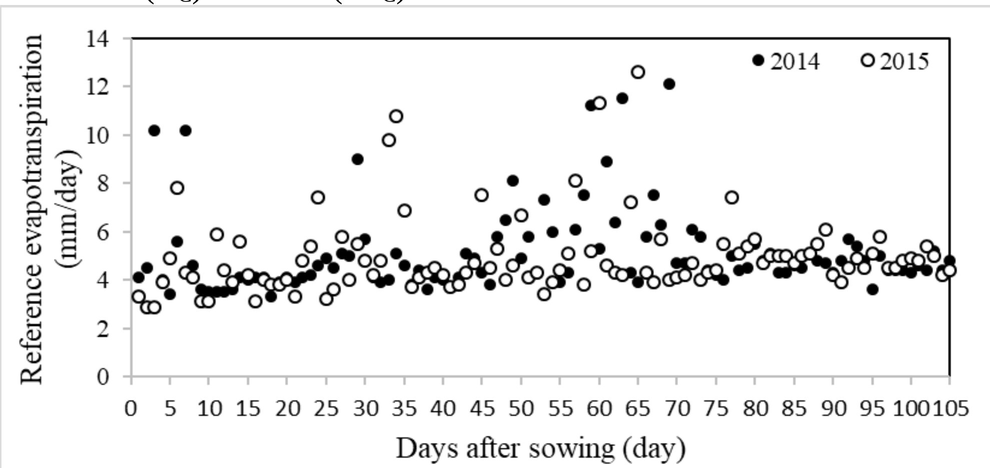
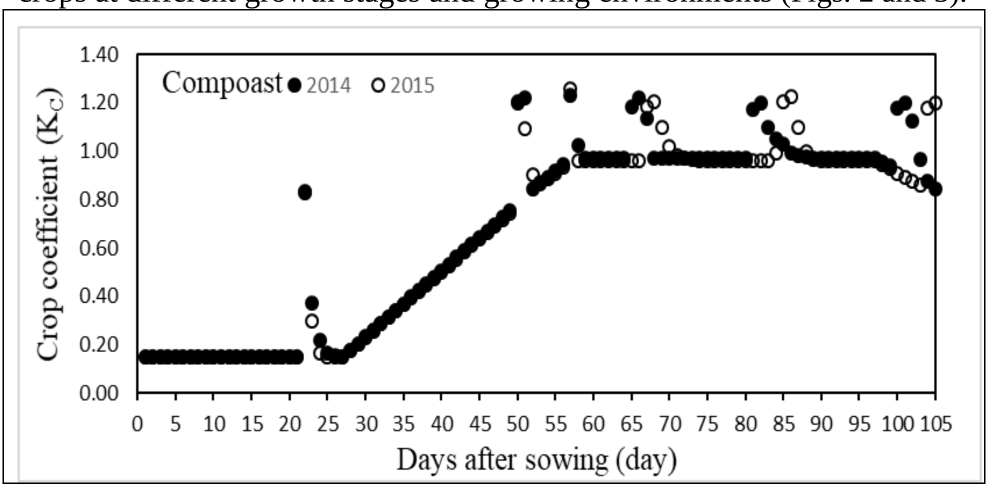


Fig. 2. Daily reference evapotranspiration for both growing seasons of the experimental site.

Reference evapotranspiration is calculated using the weather data as input to the Penman–Monteith equation and the crop coefficient is used to adjust the estimated reference evapotranspiration for grass to that of other crops at different growth stages and growing environments (Figs. 2 and 3).



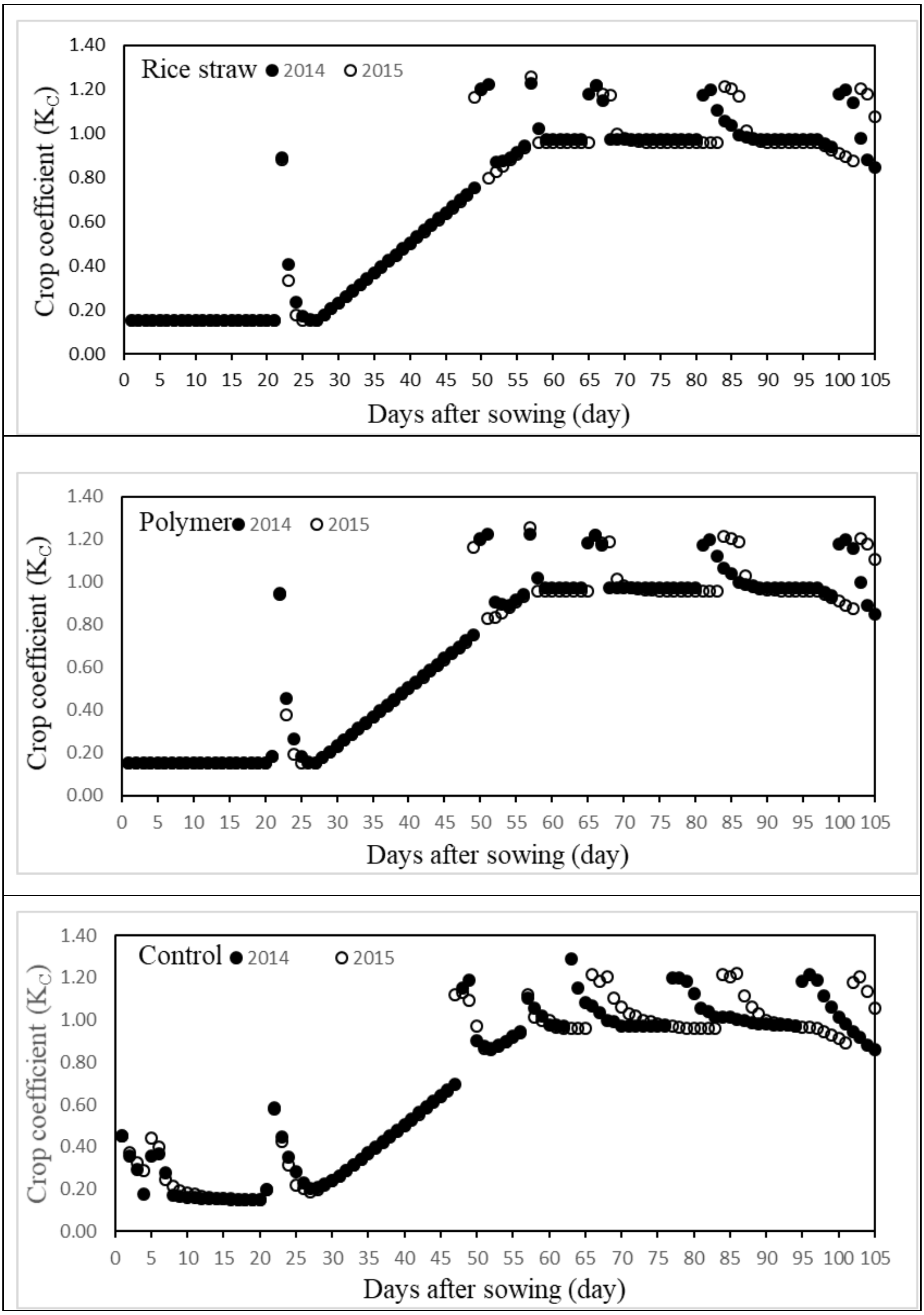


Fig. 3. Crop coefficient under different soil conditioners for both growing seasons.

2.5. Soil moisture measurement

The moisture content in the soil is measured using the soil moisture probe, which has been calibrated using the gravimetric method. Time domain reflectometry (Three-pin bore hole probe + adapter, Eijkelkamp Agriresearch Equipment, Netherland) device consists of a polycarbonate rod 25mm diameter, with electronic sensors were placed in pairs in the form of rings of stainless steel and were installed on equal distances on the length of the rod. The soil moisture content was measured at 5cm away from the emitter by using TDR. The soil moisture was preserved between field capacity and the refill point which represents 50% of the total available water in the soil.

This is a common strategy not only for conventional irrigation systems but also for drip irrigation system, especially when applied to sandy soils, arid climate and saline water without any leaching. This strategy has helped to make salts as far as possible from the root zone with help of soil conditioners as a means to overcome the challenges facing the desert areas in Egypt, which suffer from these problems in addition to the growing problem of salinity of groundwater due to over pumping, which resulted in an imbalance between the rate of pumping and the rate of recharge of underground reservoirs in addition to the lack of rain amounts usual fall as a result of climate changes emerged use this strategy with the help of soil conditioners as a solution.

The soil moisture measuring points were 10cm apart till 40cm depth as a vertical axis and 30cm as horizontal axis which represents the distance between plants. The soil moisture measurements were applied before and immediately after irrigation and the data obtained was plotted by Surfer software to see the impact of the use of soil conditioners to improve the soil's capacity to retain water and increase soil moisture content.

2.6. System installation and experimental treatments

Field experiment includes three treatments of subsurface drip tapes and four treatments of soil conditioners. Drip tapes treatments were (GR (Eurodrip Egypt, I_1); GR anti-root (Rain Bird Egypt, I_2); and T-tape (Eurodrip Egypt, I_3)), while the soil conditioners treatments were (Compost (S_1); Rice straw (S_2); Polymer (S_3); and Control (S_4)), and three replicates were adopted for each field treatment. The amounts of applied soil conditioners were; compost (10 ton/fed), rice straw (10 ton/fed), and polymer (1760 kg/fed), the soil conditioners were manually added at a depth ranged from 10-20 cm. Irrigation water was applied according to potential evapotranspiration, soil retention information and crop factor during the growing season which was confirmed by soil moisture monitoring.

The irrigation system (Fig. 4) consists of; screen filter 200 mesh, 36 laterals with 15m length for each were built-up on an area equal to 0.0432 ha (15m width and

28.8m length) with zero slope. Subsurface laterals were located in a trenches prepared by hand. Bridging the trenches were then carefully using soil that was removed previously. Dripper's lines consists of polyethylene with a diameter of 16 mm, the manifold was 32mm diameter PVC pipe.

2.7. Evaluation of drip tapes

Hydraulic characteristics experiments were carried out for three types of built-in laterals (GR, GR Anti roots, and T-Tape). 25 emitters were nominated randomly to evaluate the drip tapes by estimating the water application efficiency through dividing the volume of water collected in catch-cans by the estimated time of the experiment. The water application uniformity was calculated through the terminologies of the manufacturer coefficient of variation (v) and emission uniformity (EU) by adopting equations (1) and (2) (Keller and Karmeli, 1975) as follows:

$$v = \frac{S}{q_a} \quad (1)$$

$$EU = 100(1.0 - 1.27\frac{v}{\sqrt{N_p}}) \quad (2)$$

where S is the standard deviation of emitters flowrate (lph); q the average discharge of tested emitters (lph), N'_P the number of emitters per plant, q_n the minimum flow rate (l/h), q_a The average flow rate of all emitters (lph) (Table 5). The subsurface drip irrigation system was rated according to the standard classification of the American Society of Agricultural Engineering, which ranges from excellent to unacceptable. (ASAE, 1996a; ASAE, 1996b).

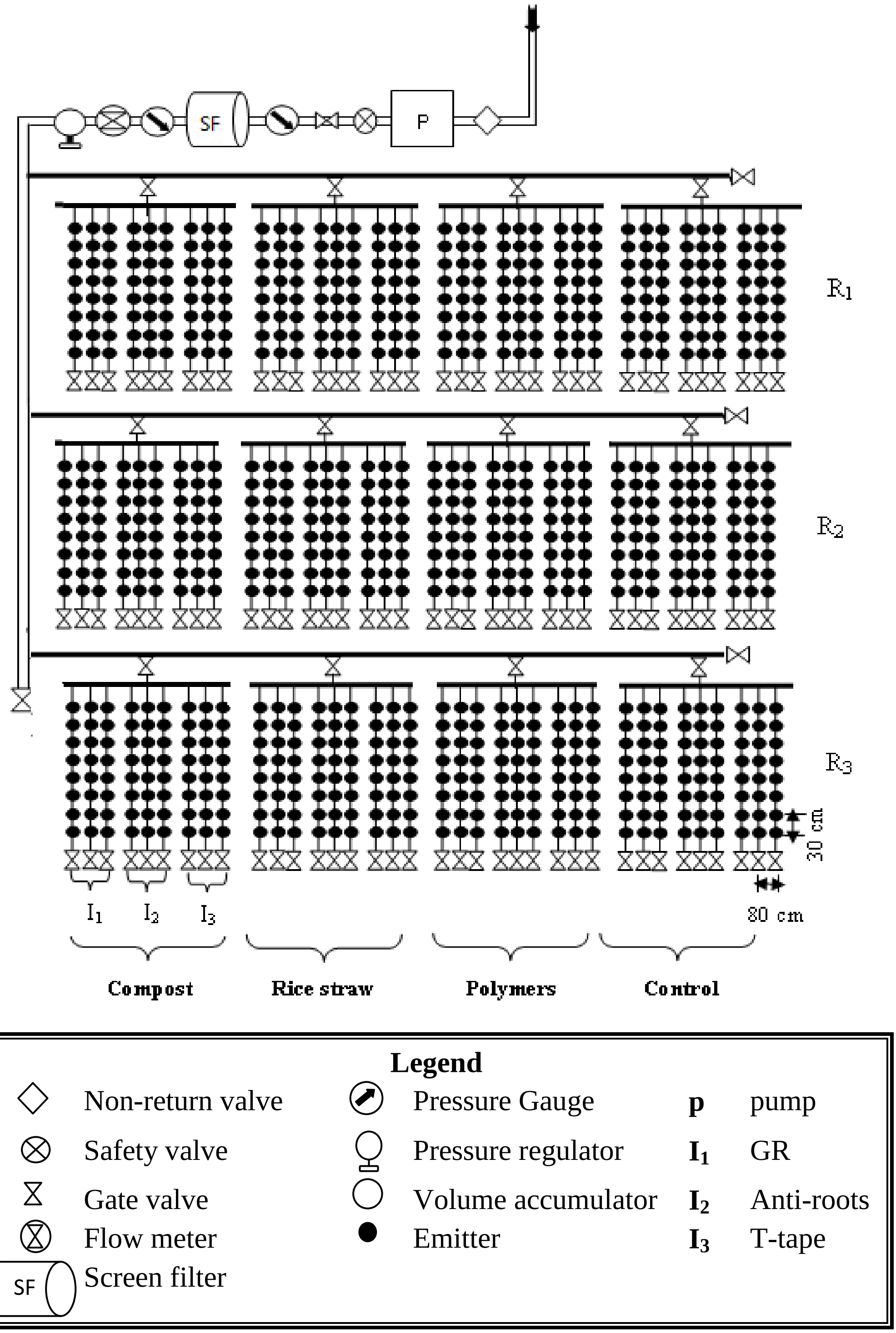


Fig. 4. Schematic sketch of micro-irrigation system components and treatments.

Table 5. Hydraulic properties of lateral drip tapes.

Characteristics	Lateral		
	GR	GR anti-root	T-tape
Wall thickness (mm)	1	1.2	0.3
Internal diameter (mm)	16	16	16
Pressure compensating	No	Yes	No
Emitter flowrate (lph)	4	4	4
Emitter spacing (cm)	30	30	30.0
Lateral spacing (cm)	80	80	80
Lateral placement depth (cm)	15.0	15.0	15.0
Exponent (x)	0.5	0.5	0.5
CV	1.49	3.15	2.96
EU	97.1	98.8	96

2.8. Data recording

The final harvest was on 30th of July (105 days after planting (DAP)), 18 plants were harvested from each plot by taking six plants from each of the beginning, middle and end of the plot respectively, to estimate productivity.

Total fresh weight of the fruits was determined (kg per plant). The vegetative parameters were plant height, number of branches, number of leaves per plant, fruit diameter, fruit length, fruit weight and fresh weight per plant was derived from final plant harvest. The actual evapotranspiration of cucumber during the growing period was assessed from the soil-water equilibrium through the following equation:

$$ET = I + P \pm \Delta SW - Dp - R \tag{3}$$

Where ET is the evapotranspiration (mm), I the amount of irrigation water applied (mm), ΔSW the soil water content changes (mm), Dp the deep percolation (mm), and R is the amount of runoff (mm). Since the amount of irrigation water was controlled, and the same saline irrigation water was used for all treatments, and there was no leaching, therefore the buildup of soil salinity would have been very similar, and so the deep percolation and runoff were assumed to be negligible, on the other hand, by this way the effect of using soil conditioners with saline irrigation water can be summarized on the yield and water productivity. The water productivity (kg m^{-3}) was computed using Eq. (4) given by Bhushanet al. (2007).

Water productivity (kg m^{-3}) = yield (kg ha^{-1})/plant water consumption (m^3 ha^{-1}) (4)

2.9. Statistical analysis

All measurements in this research were analyzed using the analysis of variance (ANOVA), where it convenient for split plot design in factorial arrangement three factors soil conditioners, laterals hoses and three replicates as blocks. The mean square of a product between the soil conditioners and laterals hoses were used as an error term to test the interaction between each of the factors. The less significant difference (LSD) of Duncan’s test has been used to determine the statistical significant differences between average groups in the ANOVA. Classified the probability levels less than 0.05 as significant. All analyses were done by using the MSTAT program (MSTAT is written in the C programming language and runs on DOS compatible machines).

3. RESULTS AND DISCUSSIONS

3.1. Irrigation and evapotranspiration

The monthly evapotranspiration and irrigation water applied values calculated in the experiment area using daily weather data. The result show that, there was a decreasing percentage of total evapotranspiration (ET) under soil conditioners treatments of cucumber plant comparing with control by 1.8 %, and 1.6 % and 1.24% under compost (S_1), rice straw (S_2), and polymers (S_3), respectively, for the first season, while it was lower by 1.72 %, 1.49 % and 1.16% under S_1, S_2, and S_3 respectively comparing with control, for the second season. While there was a decreasing percentage of total the irrigation water applied (I) under soil conditioners treatments of cucumber plant comparing with control by 2.92 %, 2.47% and 2.29%, under compost (S_1), rice straw (S_2), and polymers (S_3), respectively, for the first season, while it was lower by 2.99%, 2.71%, and 2.45% under S_1, S_2 and S_3 treatments respectively comparing with control, for the second season (Table 6).

3.2. Yield and water productivity

The yield (the fresh weight of fruits) was 20.12%, 34.42% and 57.31% higher, in the compost with GR anti-root (I_2S_1) comparing with rice straw (I_2S_2), polymers (I_2S_3), and control (I_2S_4) respectively, for the first season (Table 8), while it was higher by 16.7 %, 32.7 and 53.8% than (I_2S_2), (I_2S_3), and (I_2S_4), respectively, for the second season (Table 7).

The water productivity was greater by 10.16% and 11.8% under compost with GR anti root (I_2S_1) comparing with compost with GR (I_1S_1) and compost with t-tape (I_3S_1), respectively, for the first season, while it was greater by 8.34% and 9.5% than (I_1S_1) and (I_3S_1), respectively, for the second season.

The results of yield and water productivity agree with Roe et al. (1997), who studied green peppers and cucumbers in a sandy soil fertilized with compost or mineral fertilizers. And they found that, yields were usually higher when compost was combined with mineral fertilizers. Compost treatment gave significantly greater early, exportable and total yield than inorganic (chemical) treatment (Aly, 2002). In this respect, Ali et al. (2006), also found that the application of compost for tomatoes increased water productivity, this could be due to the role of rice straw compost as organic fertilizer on better water holding in the root zone.

The achievement of the highest yield and water productivity under compost treatment was according to that that compost-amended soils exhibited increases in quantity and quality of total organic carbon, nitrogen, phosphorus, microbial biomass, and enzymatic activities (Mylavarapu and Zinati, 2009).

The sequential applications of compost with and without fertilizer increased nutrient uptake and soil nutrient concentrations, soil water retention, and reduced soil bulk density. Obviously compost applications have significant amounts of total carbon and nitrogen, potentially improving the physical and chemical properties of the soils for sustaining optimum crop production (Mylavarapu and Zinati, 2009).

Increased yield was also related to balanced nutrition, better uptake of nutrients by the plants which helped for better fruit set and fruit yield. More yield of cucumber in present study could be due to the influence of bio-fertilizers in combination with N-P-K and FYM enhanced the synthesis of photosynthetic by increasing the synthesis of growth regulators.

The lower yield and so water productivity under polymer treatment was related to that most polymeric super absorbents are based on sodium poly acrylate, but they are not suitable for saline water and soils (Akelah, 2013).

The control treatment had the lowest values of soil nutrients, growth and yield parameters of cucumber when compared to other treatments this is related to the saline irrigation water. The result was also supported by (Moyin-Jesu and Ojeniyi, 2006).

3.3. Soil moisture content

The distribution of water through soil profile of sandy soil under subsurface trickle irrigation system is regarded as one of the most significant factor for good soil water management.

Compost has uniformity in soil moisture content the maximum soil moisture content values before and after irrigation were detected at depth ranged from 10-30 cm and it was 11%, and 21% before and after irrigation respectively, and gradually decreased up and down till the minimum values at soil surface were 3%, and 5% before and after irrigation respectively, and 6.5%, and 17% before and after irrigation respectively, at 40 cm depth (Fig. 5).

The soil moisture content for rice straw, it turned out that there were high and low moisture content spots, the great moisture content was detected at layer ranged from 15-35 cm before and after irrigation, and it were 6% and 18% before and after irrigation respectively, and gradually decreased up and down, till the lowest values at soil surface was 2.5%, and 4% before and after irrigation respectively, and 5%, and 12% before and after irrigation respectively, at 40 cm depth. According to the high permeability of rice straw the water infiltrate downward fast (Fig. 6).

The polymer treatment achieved the highest soil moisture content with 24% after irrigation, and it was detected at depth ranged from 10-25 cm and it gradually decreased in the two direction up and down till the lowest soil moisture content 3% at soil surface and 5% at 40 cm depth, the depth ranged from 10-25 cm already reached to field capacity 21% for the sandy soil with polymers (Fig. 7).

Table 6. Monthly water applied for each soil conditioner treatment under growing seasons.

Year	Soil cond.	April		May		June		July		Total	
		ET (m^3ha^{-1})	I (m^3ha^{-1})	ET (m^3ha^{-1})	I (m^3ha^{-1})	ET (m^3ha^{-1})	I (m^3ha^{-1})	ET (m^3ha^{-1})	I (m^3ha^{-1})	ET (m^3ha^{-1})	I (m^3ha^{-1})
2014	Com.	818	1072	900	1220	897	1647	877	950	3492	4889
	R.S.	823	1078	901	1222	898	1649	878	963	3500	4912
	Pol.	831	1080	903	1225	900	1652	880	964	3513	4921
	Cont.	799	1109.1	988	1252.7	891	1698.4	879	976.13	3557	5036.3
2015	Com.	815	1014	897	1138	870	1558	901	947	3484	4657
	R.S.	826	1017.6	894	1140.9	870	1563.2	902	948.8	3492	4670.5
	Pol.	834	1020.3	896	1142	872	1567	904	952	3504	4681.3
	Cont.	805	1051	984	1166.1	881	1603.0	876	980.7	3545	4800.8

Table 7. The characteristics of water productivity and yield of cucumber for different lateral drip tapes and soil conditioners and the interactions between them for both growing seasons.

Year	Treatments	I (m^3 h^{-1})	ET (m^3 h^{-1})	Yield (t h $^{-1}$)	Water productivity (kg m^{-3})
2014	I_1	4939.58	4150	19.66b	4.76b
	I_2	4939.58	4150	20.653a	4.99a
	I_3	4939.58	4150	18.631c	4.45c
	LSD	NS	NS	0.28	0.036
	S_1	4889	4093	27.82a	6.79a
	S_2	4912	4104.2	19.69b	4.79b
	S_3	4921	4120.9	17.77c	4.3c
	S_4	5036.3	4283.0	12.96d	3.01d
	LSD	NS	Ns	0.3	0.04
	I_1S_1	4889	4093	27.22b	6.65b
	I_1S_2	4912	4104	19.57e	4.769e
	I_1S_3	4921	4120	18.46h	4.481f
	I_1S_4	5036.3	4283	13.4f	3.129i
	I_2S_1	4889	4093	30.33a	7.41a
	I_2S_2	4912	4104	20.16d	4.912d
	I_2S_3	4921	4120	18.27f	4.434f
	I_2S_4	5036.3	4283	13.85h	3.234h
	I_3S_1	4889	4093	25.92c	6.333c
	I_3S_2	4912	4104	19.35e	4.715e
	I_3S_3	4921	4120	16.57g	4.022g
	I_3S_4	5036.3	4283	11.62i	2.713j
	LSD	NS	NS	0.5	0.08
2015	I_1	4702.4	3950.8	20.07b	5.11b
	I_2	4702.4	3950.8	21.49a	5.55a
	I_3	4702.4	3950.8	18.1c	4.61c
	LSD	NS	NS	0.2	0.19
	S_1	4657	3889.3	27.93a	7.18a
	S_2	4670.5	3904	20.45b	4.24c
	S_3	4681.3	3926	18.45c	4.7b
	S_4	4800.8	4083.9	12.7d	3.2d
	LSD	NS	NS	0.3	0.17
	I_1S_1	4657	3889.3	27.486b	7.067b
	I_1S_2	4670.5	3904	20.944d	5.365d
	I_1S_3	4681.3	3926	18.618g	4.742e

I_1S_4	4800.8	4083.9	13.245j	3.243h
I_2S_1	4657	3889.3	30.505a	7.843a
I_2S_2	4670.5	3904	21.029d	5.387d
I_2S_3	4681.3	3926	20.738e	5.282d
I_2S_4	4800.8	4083.9	13.704i	3.356g
I_3S_1	4657	3889.3	25.821c	6.639c
I_3S_2	4670.5	3904	19.394f	4.968e
I_3S_3	4681.3	3926	16.047h	4.087f
I_3S_4	4800.8	4083.9	11.16k	2.733i
LSD	NS	NS	0.13	0.29

Note: Numbers followed by different letters within the growing season are statistically different ($P \leq 0.05$).

The maximum soil moisture content values before and after irrigation under control treatment were detected at depth ranged from 10-25 cm and it was 6.6%, and 12% before and after irrigation respectively, and gradually decreased up and down till the minimum values at soil surface were 3.8%, and 5% before and after irrigation respectively, and 5%, and 8.7% before and after irrigation respectively, at 40 cm depth (Fig. 8).

The result showed that the water front distribution for rice straw and control treatments was moved downward faster with depth than the polymers and compost treatments under different drip tapes types. On the other hand, El-Berry et al. (1989), pointed out that in subsurface trickle, the minimum moisture content was observed in the upper layer (0-5 cm) before and after irrigation where it was (2.4%), the moisture percentage increased with depth to reach its maximum value at a depth of 22 cm below the lateral in sandy soil.

The application of polymer to the soil increases the water available for the plant. Available moisture content has increased in the soil for plant under polymer treatment, it can be in accordance with the structure of the polymer and hydrophilic properties of the polymer. The pore size distribution and soil capillary are of the factors that affecting on soil water retention capacity and accordingly soil moisture content under suction application. Super absorbent polymer has hydrophilic properties, leading to the creation of changes in soil properties such as increased soil moisture content, porosity and small capillary effect (Shahrokhian et al., 2013).

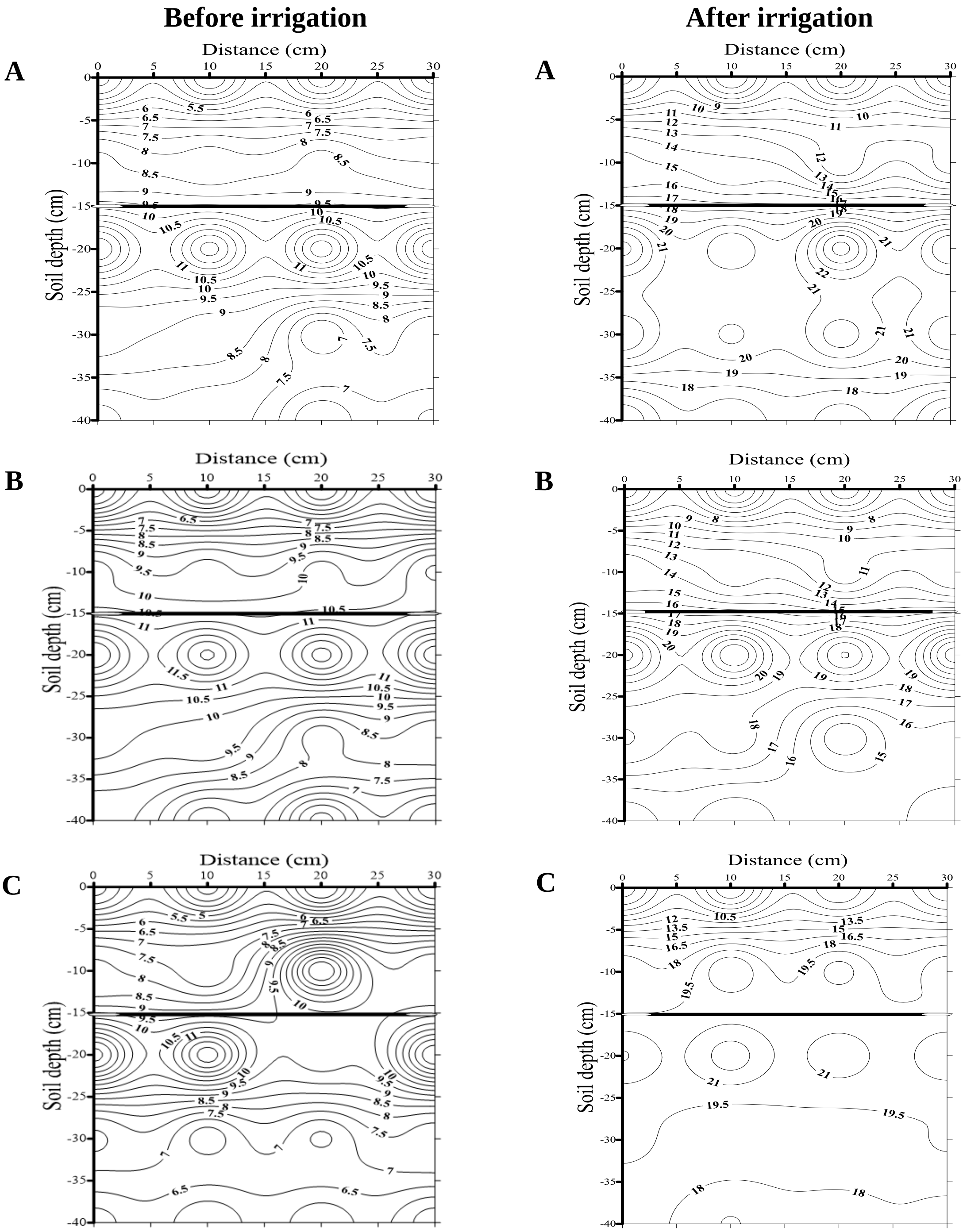


Fig. 5. Soil moisture distribution under compost for different drip tapes (A: GR, B: GR anti-root and C: T-tape).

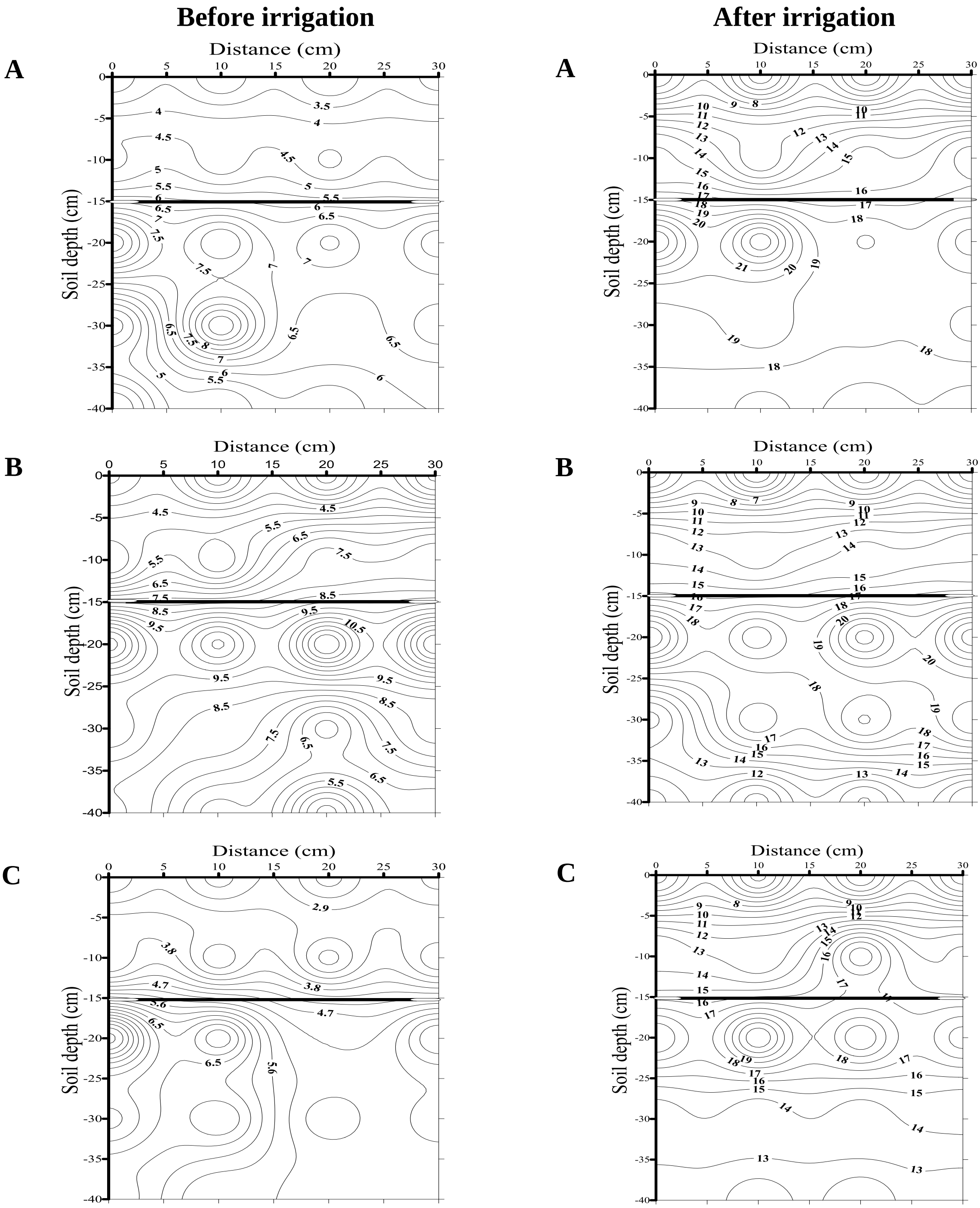


Fig. 6. Soil moisture distribution under rice straw for different drip tapes (A: GR, B: GR anti-root and C: T-tape).

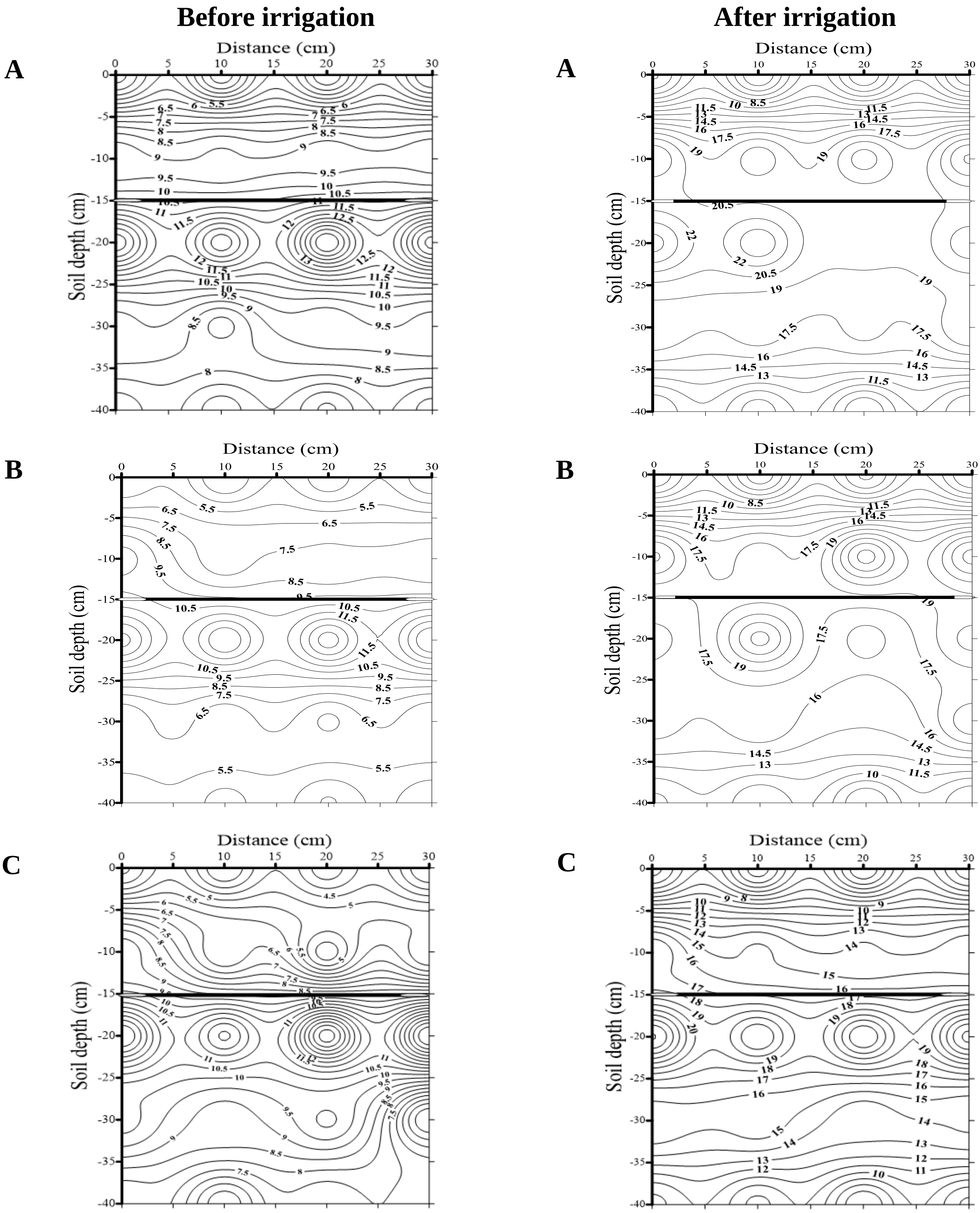


Fig. 7. Soil moisture distribution under polymer for different drip tapes (A: GR, B: GR anti-root and C: T-tape).

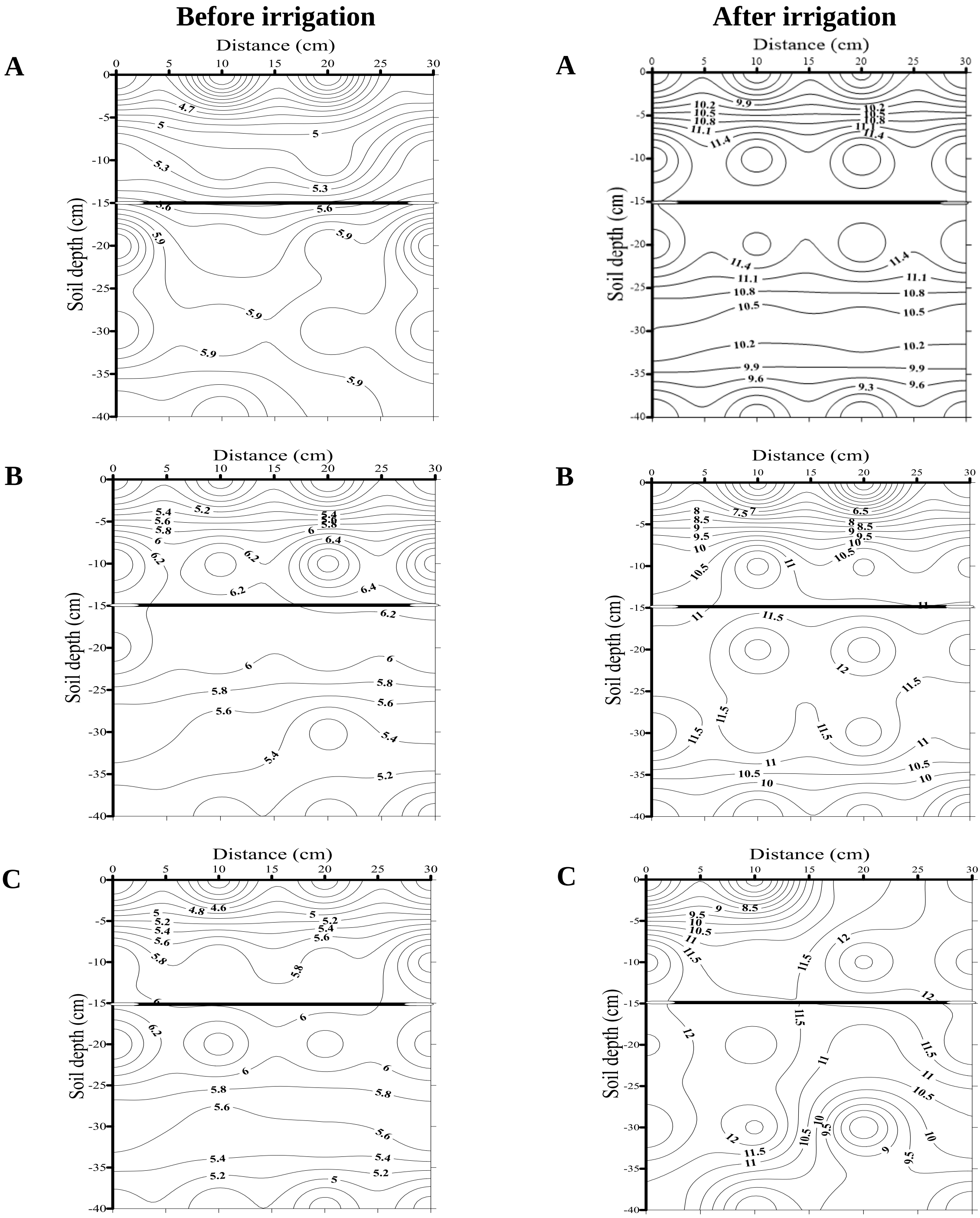


Fig. 8. Soil moisture distribution under control for different drip tapes (A: GR, B: GR anti-root and C: T-tape).

3.4. Vegetative growth parameters

The growth characteristics of cucumber showed a significant difference between the three soil conditioners (S_1, S_2, and S_3) for the two growing seasons, furthermore, there were significant differences between drip tapes treatments (I_1, I_2 and I_3) for plant height, number of branches, number of leaves and fruit weight, while for the rest of vegetative parameter there is no significant difference. The interaction between soil conditioners and irrigation drip tapes treatments most of vegetative parameters were significant differences except number of branches, Fruit length, and Fruit diameter for both growing seasons (Table 8).

Plant height is not a productivity indicator in the vegetables, but it illustrates the effect of different nutrients on metabolism. There were significant differences in plant height between lateral drip types, soil conditioners, and the interactions between them for both growing seasons. For drip types treatments there was 5.5%, and 4.5% increase in plant height under GR anti-roots comparing with GR and T-tape for the first season, and 4.7%, and 8.1% in plant height under GR anti-roots comparing with GR and T-tape in the second season. For soil conditioners, there was 8.8%, 16.1%, and 33.5% increase in plant height of cucumber under compost comparing with rice straw, polymer, and control (without soil conditioner) for the first season, while there was 8.5%, 18.6%, and 29.1% increase in plant height of cucumber under compost comparing with rice straw, polymers, and control treatments for the second season. For the interaction between the lateral drip types and soil conditioners, the maximum value of plant height was (166.3 cm) under compost with anti-roots treatment (I_2S_1), while the minimum value was (102 cm) under control with GR (I_1S_4), for the first season, and the maximum value of plant height was (162 cm) under compost with GR anti-roots treatment, while the lowest value was (104 cm) under control with T-tape, for the second season (Table 8).

For the first season, there was a significant difference of number of branches between lateral drip tapes, and between soil conditioners, while there was no significant difference between the interactions between them. For the second season there was significant difference between soil conditioners and there is no significant difference between lateral drip tapes and interaction between them. With respect to vegetative parameters, the number of branches had the highest values (22.66) under compost with t-tape (I_3S_1), while the lowest value was (11.0) and it was recorded under polymer with GR anti-roots (I_2S_3), for the first season, while the highest values of number of branches was (22.60) under (I_3S_1), while the lowest value was (11.33) was recorded under (I_2S_3), for the second season.

Table 8. Vegetative growth parameters of cucumber in different years and treatments.

year	Treatment	Plant height (cm)	No. of branches	No. of leaves	Leaves area (cm^2)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)
2014	I_1	133.61b	14.58b	24.02b	157.70	16.03	2.57	98.76b
	I_2	141.33a	15.16b	26.16a	161.61	16.58	2.69	120.71a
	I_3	134.92b	17.58a	23.56b	155.46	15.83	2.48	117.00a
	LSD	1.646	1.86	0.62	NS	NS	NS	16.53
	S_1	160.02a	21.11a	30.67a	193.67a	17.20a	2.87a	128.97a
	S_2	145.89b	16.00b	23.8c	173.36b	16.90a	2.60b	113.80ab
	S_3	134.21c	12.11c	26.61b	155.95c	14.82b	2.39c	105.48b
	S_4	106.35d	13.88bc	17.25d	110.04d	15.67c	2.45bc	100.38b
	LSD	1.78	3.07	1.05	4.21	0.71	0.16	19.59
	I_1S_1	156.45bc	20.66	30.5b	192.67	16.76	2.81	116.76
	I_1S_2	143.97d	14.33	24fg	178.26	16.60	2.68	93.70
	I_1S_3	131.17f	11.00	26.4de	148.43	14.96	2.36	91.80
	I_1S_4	102.83h	12.33	15.25i	111.33	15.80	2.44	92.80
	I_2S_1	166.29a	20.00	32.5a	195.70	18.13	3.16	144.10
	I_2S_2	153.74c	16.33	24.9ef	175.96	16.60	2.63	130.03
	I_2S_3	138.18e	11.00	27.75cd	163.93	15.33	2.49	108.33
	I_2S_4	107.12g	13.33	19.5h	110.86	16.26	2.47	100.40
	I_3S_1	157.3b	22.66	29bc	192.56	16.70	2.65	126.06
	I_3S_2	139.98e	17.33	22.5g	165.86	17.50	2.51	117.66
	I_3S_3	133.28f	14.33	25.75ef	155.50	14.16	2.34	116.66
	I_3S_4	109.1g	16.00	17i	107.93	14.96	2.44	107.96
	LSD	3.078	NS	1.83	7.30	NS	NS	NS
2015	I_1	129.77b	15.00	22.01b	157.95b	16.23	2.63	105.29b
	I_2	136.18a	15.33	23.24a	163.35a	16.55	2.64	117.50a
	I_3	125.27c	17.58	22.075b	152.6c	16.35	2.50	115.92a
	LSD	2.612	NS	0.2	1.04	NS	NS	6.94

S_1	151.89a	21.33a	29.38a	192.32a	17.62a	2.95a	129.47a
S_2	138.89b	16.44b	19.951c	174.88b	16.43b	2.63b	113.83b
S_3	123.64c	12.22c	24.367b	157.95c	15.17c	2.30c	104.27b
S_4	107.71d	13.88c	16.07d	106.7d	16.28b	2.49b	104.04b
LSD	5.99	1.86	0.166	1.19	0.52	0.17	14.44
I_1S_1	149.84b	21.00	28.9b	190.77b	17.30	2.92	119.66
I_1S_2	139.36bcd	14.66	19.65gh	178.27d	16.30	2.76	101.22
I_1S_3	121.67ef	11.66	24.2e	158.43g	15.30	2.34	96.57
I_1S_4	108.21g	12.66	14.96k	105.33j	16.03	2.51	103.73
I_2S_1	162.28a	20.33	31.08a	198.7a	18.10	3.19	142.90
I_2S_2	141.52bc	17.33	20.12g	177.9d	15.93	2.68	124.33
I_2S_3	130.08de	11.33	23.85f	165.9f	15.40	2.29	102.16
I_2S_4	110.85fg	12.33	17.92i	110.88i	16.80	2.42	100.60
I_3S_1	143.56bc	22.60	28.17c	187.5c	17.46	2.74	125.86
I_3S_2	134.29cd	17.33	19.75h	168.8e	17.06	2.46	115.93
I_3S_3	119.15f	13.66	25.05d	150.5h	14.83	2.90	114.10
I_3S_4	104.08g	16.66	15.33j	103.9j	16.03	2.54	107.80
LSD	10.37	NS	0.287	2.06	NS	NS	NS

Note: Numbers followed by different letters within the growing season are statistically different ($P \leq 0.05$).

The number of leaves showed that for the first season there was significant difference between soil conditioners, and the interactions between lateral drip types and soil conditioners, while there was no significant difference between lateral drip types. For the second season, there was a significant difference in number of leaves among lateral drip types, soil conditioners, and the interactions between them.

Concerning with the interaction, results showed that number of leaves achieved the highest value (33 leaves) under compost with GR anti-roots (I_2S_1), and the lowest value (15 leaves) under GR with control (I_1S_4), for the first season, while the highest value (31 leaves) for (I_2S_1), and the lowest values was (15 leaves) for (I_1S_4), for the second season (Table 8).

The leaves area per plant under drip tapes, the highest value was (161.6 cm^2), and the lowest value of leaves areas (155.46 cm^2) for I_2 and I_3 treatments, respectively, for the first season, while the highest value was (162.3 cm^2), and the lowest value (152 cm^2) for GR anti-root (I_2) and T-tape (I_3) treatments, respectively, for the second season. For soil conditioners, the compost (S_1) treatment was higher by 10%, 19%, and 43% in leaves areas comparing with rice straw (S_2), polymer (S_3) and control (S_4) treatments (control) for the first season, while the compost (S_1) was higher than (S_2), (S_3) and (S_4) by 9.1%, 18%, and 44.5%, respectively for the second season (Table 8).

The interaction between the lateral drip types and soil conditioners, the highest values of leaves areas (196 cm^2), and the lowest values of leaves areas (107 cm^2) for (I_2S_1) and (I_3S_4) treatments, respectively, for the first season, while the highest values was (198.7 cm^2), and the lowest values (104 cm^2) for (I_2S_1) and (I_3S_4) treatments, respectively, for the second season (Table 8).

The outcomes displayed that, there was significant difference in fruit length among soil conditioners for both growing seasons, but there was no significant difference among lateral drip tapes and the interferences between lateral drip tapes and soil conditioners for both grown seasons.

For lateral drip tapes, the highest value of fruit length (16.6 cm), and the lowest value of fruit length (15.8 cm) were detected under I_2 and I_3 treatments, respectively, for the first season, while the highest value was (16.5 cm), and the lowest value (16.2 cm) for I_2 and I_1, respectively, for the second season, for soil conditioners, there was 1.7%, 13.8%, and 8.9% increase in fruit length in compost treatment (S_1) comparing with rice straw (S_2), polymer (S_3) and control (S_4) for the first season, while compost was higher than rice straw (S_2), polymer (S_3) and control (S_4) treatment by 6.7%, 14%, and 7.6%, respectively, for the second season.

The interaction between the lateral drip tapes and soil conditioners showed that the highest values of fruit length (18.1 cm), and the lowest values of leaves areas (14.1 cm) for compost with GR anti-roots (I_2S_1) and polymer with GR (I_1S_3) treatments, respectively, for the first season, while the highest values was (18 cm), and the lowest values (15 cm) for I_2S_1) and (I_3S_3) treatments, respectively, for the second season (Table 8).

There was significant difference in fruit diameter among soil conditioners for both growing seasons, but there was no significant difference between lateral drip tapes, the interactions between lateral drip tapes and soil conditioners for both grown seasons. For lateral drip tapes, the highest values of fruit diameter (2.7 cm), and the lowest values of fruit diameter

(2.4 cm) for GR anti-roots (I_2) and T-tape (I_3) treatments, respectively, for the first season, while the highest value was (2.6 cm), and the lowest value (2.5 cm) for GR anti-root (I_2) and T-tape (I_3) treatments, respectively, for the second season.

With respect to the soil conditioners, there was 9.4%, 16.7%, and 14.6% increase in fruit diameter in (S_1) comparing with rice straw (S_2), polymer (S_3) and control (S_4) treatments, for the first season, while there was 10.8%, 22%, and 15.6% increase in fruit diameter in (S_1) comparing with rice straw (S_2), polymer (S_3) and control (S_4) for the second season.

The interaction between the lateral drip tapes and soil conditioners, the highest values of fruit diameter (3.1 cm), and the lowest values of leaves areas (2.34 cm) for compost with GR anti-roots (I_2S_1) and polymer with T-tape (I_3S_3) treatments, respectively, for the first season, while the highest values was (3.2 cm), and the lowest values (2.3 cm) for compost with GR anti-roots (I_2S_1) and polymer with GR (I_1S_3) treatments, respectively, for the second season (Table 8).

With respect of fruit weightiness, there was a significant difference among soil conditioners, and lateral drip tapes, while there was no significant difference of interaction among lateral drip tapes and soil conditioners for both growing seasons (Table 8).

For lateral drip tapes, the highest and lowest values of fruit weight were (120.7 g) and (98.7 g), for GR anti-roots (I_2) and GR (I_1) treatments, respectively, for the first season, while the highest and lowest values of fruit weight were (116.5 g) and (105.3 g), for GR anti-roots (I_2) and GR (I_1) treatments, respectively, for the second season.

For soil conditioners, there was 11.8%, 18.2%, and 22.2% increase in fruit weight in compost (S_1) treatment comparing with rice straw (I_2), polymers (I_3), and control (I_4) treatments, for the first season, while there was 12.1%, 19.5%, and 19.6% increase in fruit weight in (S_1) treatment comparing with (I_2), (I_3), and (I_4) treatments, for the second season.

For the interaction between the lateral drip tapes and soil conditioners, the highest values of fruit weight (130 g), and the lowest values of fruit weight (92 g) for (I_2S_2) GR anti-roots with compost and GR with polymer (I_1S_3) treatments, respectively, for the first season, while the highest and lowest values of fruit weight were (143 g) and (96.6 g) for (I_2S_2) and (I_1S_3), respectively, for the second season (Table 8).

The increase in the dimensions of the fruit (length and diameter) can be attributed to balanced nutrition, and improve the ability of the plant to absorb nutrients, which is composed of a high proportion of carbohydrates, this positive impact was achieved through a combination of adding organic and bio-fertilizers that effect on increasing of chlorophyll content in the leaves, which leading to increased photosynthesis and consequently increased fruit dimensions and so productivity (Umamaheshwarappa et al., 2005).

4. CONCLUSIONS

The use of soil conditioners in this research intended to improve the yield and water productivity and quality of cucumber crop in sandy soil. The main conclusions of this research are:

- ✓ Compost application with subsurface drip tapes achieved higher yield, water productivity and made an improvement under salinity, especially with GR anti-roots drip tape.
- ✓ In general, all soil conditioners, have a positive impact, whether in small or large degree on the physicochemical characteristics of the soil and on cucumber plants. The growth characteristics of cucumber were enhanced when adding compost to the soil.
- ✓ There were no differences between any lateral drip tapes under soil conditions (GR, GR anti roots, and T-tape) on yield and plant growth and water productivity
- ✓ The positive results related to soil conditioners were obtained under a small plot area (0.0432ha.) which support declared results acquired from experiments performed on a commercial farm, and are sufficiently heartening to warrant pursue field work on larger areas in sandy soil.

REFERENCES

Akelah, A., 2013. Functionalized polymeric Materials in Agriculture and the food Industry. Springer New York Heidelberg Dordrecht London.

Akhter, J., Mahmood, K., Malik, K.A., Mardan, A., Ahmad, M., Iqbal, M.M., 2004. Effects of hydrogel amendment on water storage of sandy loam and loam soils and seedling growth of barley, wheat and chickpea. Plant Soil Environ, 50, 463–469.

Ali, H.I., Ismail, M.R., Manan, M.M., Saudi, H.M., 2006. Rice straw compost and water deficit affect yield, quality and water productivity of tomatoes grown in different media. Biol. Agric. Hortic., 24: 301-316.

Al-Omrana, A. M., Shetaa, A. S., Falataha, A. M., Al-Harbib, A. R., 2004. Effect of drip irrigation on squash (Cucurbita Pepo) yield and water productivity in sandy calcareous soils amended with clay deposits. Agricultural Water Management, 73: 43-55.

Aly, H.H., 2002. Studies on keeping quality and storage ability of cucumber fruits under organic farming system in plastic-houses.MSc Thesis, Hort. Dept., Cairo Univ., Egypt.

ASAE. 1996a. Field Evaluation of Micro Irrigation Systems.EP405.1. ASAE Standards. Amer. Soc. Agric. Engr., St. Joseph, MI, pp. 756–759.

ASAE. 1996b. Design and Installation of Micro Irrigation Systems. EP409. ASAE Standards. Amer. Soc. Agric. Engr., St. Joseph, MI, pp. 792–797.

Baybordi, Y.M., Malakooti, M.J., AmiriMakri, H., Nafisi, M., 2000. Production and consumption of chemical fertilizers according to sustainable agriculture aims. Agricultural education publication. Iran.

Bhushan, L., Ladha, J.K., Gupta, R.K., Singh, S., Tirol-Padre, A., Saharawat, Y.S., Gathala, M., Pathak, H., 2007. Saving of water and labor in a rice–wheat system with no-tillage and direct seeding technologies. Agron. J 99, 1288–1296.

Caravaca, F., Hernandez, T., Garcia, C., Roldan, A., 2002. Improvement of rhizosphere aggregate stability of afforested semiarid plant species subjected to mycorrhizal inoculation and compost addition. Geoderma, 108: 133-144.

Carmassi, G., Bacci, L., Bronzini, M., Incrocci, L., Maggini, R., Bellocchi, G., Massa, D., Pardossi, A., 2013. Modelling transpiration of greenhouse gerbera (Gerberajamesonii H. Bolus) grown in substrate with saline water in a Mediterranean climate. Sci. Hortic. 156, 9–18.

Chen, W., Hou, Z., Wu, L., Liang, Y., Wei, C., 2010. Evaluating salinity distribution in soil irrigated with saline water in arid regions of northwest China. Agric. Water Manage. 97, 2001-2008.

Cook, A.G.A., Kceling, A.A., Bloxham, P.F., 1998. Effect of green waste compost on yield parameters in spring Barley (Hordeumvulgare). Acta Hort, 467: 283- 286.

David, w., Adrian, C., Carl, W., 2011. Managing Soil Tilth Texture, Structure and Pore Space. PhD. Colorado State University Extension.

Davies, D.H.K., Drysdale, A., McKinlay, R.J., Dent, J.B., Williams, G.H., 1993. Novel approaches to mulches for weed control in vegetables, Proc. of a Conf. on Crop Protection in North. Britain, Dundee 23-25 March, pp: 271-276.

Dewis, J., Fartias, 1970. Physical and Chemical Methods of Soil and Water Analysis. Soil Bulletin No. 10, FAO, Rome.

El-Berry, A. M., Afifi, M.A., Ahmed, M.H., 1989. Effects of irrigation system on moisture pattern productivity and harvesting of fodder in arid lands. Misr J. Ag. Eng., 6(4): 359-371.

El-Gindy, A.M., Abdel-Mageed, H.N., El-Adl, M.A., Mohamed, E.M.K., 2001. Management of pressurize irrigated faba bean in sandy soil. Misr J. Ag. Eng., Vol.18 (1): 29-44.

Esawy, M., Ibrahim, M., Robin, P., Akkal-Corfini, N., El-Saka, M., 2009. Rice straw composting and its effect on soil properties. Compost Sci. Utilization, 17(3): 146-150.

Ferguson J.L., 2001. Evaluation the on farm composting of waste. Fur Breeders. Agricultural Co-Op summer school. August 11- Park city. Utah, USA.

Ghasem S., Morteza A.S., Maryam T., 2014. Effect of organic fertilizers on cucumber (Cucumissativus) yield. International Journal of Agriculture and Crop Sciences, 7 (11): 808-814.

Greer, L., Diver, S., 2000. Organic Greenhouse Vegetable Production, Horticulture Production Guide, Appropriate Technology Transfer for Rural Areas, Fayetteville, 31 p.

Hanson, B., May, D., 2004. Effect of subsurface drip irrigation on processing tomato yield, water table depth, soil salinity, and profitability. Agriculture Water Management. 68, 1–17.

Heikal, H.A.M., El-Sherbiny, W.A., Ghodia, R.H., 2008. Effect of irrigation system and compost addition on potato yield and calcareous soil-physical properties. The 15th.Annual Conference of the Misr Society of Ag. Eng. 425-444.

Hesse, P.R., 1971. A Text Book of Soil Chemical Analysis. Juan Murry (Publisher) Ltd, London.

Jackson, M.L., 1967. Soil Chemical Analysis. Printic Hall of India, New Delhi.

Jose O.P., Tarkalson, D.D., Irmak, S., Davison, D., Petersen, J.L., 2008. Effect of irrigation amounts applied with subsurface drip irrigation on corn evapotranspiration, yield, water productivity, and dry matter production in a semiarid climate. Publications from USDA-ARS/UNL Faculty Paper 199.

Keller, J., Karmeli, D., 1975. Trickle irrigation design. Rain Bird Sprinkler Manufacturing Corporation, Glendora, CA, 133p.

Klute, A., 1986. Methods of Soil Analysis. American Society of Agron., Inc. Madison, Wisconsin, USA.

Lakhdar, A., Hafsi, C., Debez, A., Montemurro, F., Jedidi, N., Abdelly, C., 2011. Assessing solid waste compost application as a practical approach for salt-affected soil reclamation. Acta Agric. Scand. Sect. Soil Plant Sci. 61,284–288.

Lakhdar, A., Hafsi, C., Rabhi, M., Debez, A., Montemurro, F., Abdelly, C., Jedidi, N., Ouerghi, Z., 2008. Application of municipal solid waste compost reduces thenegative effects of saline water in Hordeummaritimum L. Bioresour. Technol.99, 7160–7167.

Lakhdar, A., Rabhi, M., Ghnaya, T., Montemurro, F., Jedidi, N., Abdelly, C., 2009. Effectiveness of compost use in salt-affected soil. J. Hazard. Mater. 171, 29–37.

Melero, S., Madejon, E., Ruiz, J. C., Herencia, J. F., 2007. Chemical and biochemical properties of a clay soil under dryland agriculture system as affected by organic fertilization. Eur. J. Agron. 26: 327–334.

Moyin-Jesu, E.I., Ojeniyi, S.O., 2006. Effects of sole and amended plant residues on soil nutrient contents and yield of Okra (Abelimoschusesculentum L.). Discovery and Innovation Journal. 18(4): 318-326.

Mylavarapu R.S., Zinati G.M., 2009. Improvement of soil properties using compost for optimum parsley production in sandy soils. Scientia Horticulturae, 120, 426–430.

Neufeld, J., Davison, J., Stevenson, T., 1999. Subsurface drip irrigation, Nevada cooperative extension, Fact Sheet 97-13, University of Nevada, Reno.

Richards, L.A., 1954. Diagnosis and improving of saline and alkaline soils. U.S. Salinity Laboratory Staff. Agric. Handbook, No. 60.

Roe, N.., Stoffella, P.J., Graetz, D., 1997. Composts from various municipal solid waste feed stocks affected vegetable crops. 2: Growth, yields and fruit quality. J. Amer. Soc. Hort. Sci., 122: 433-437.

Schaumberger, A., Loiskandl, W., 2010. Assessment of Soil-Amendment Mixtures for Subsurface Drip Irrigation Systems. Institute of Hydraulics and Rural Water Management, University of

Natural Resources and Applied Life Sciences (BOKU), Vienna, Austria.

Shahrokhian, Z., Mirzaei, F., Hashemitame, M., 2013. Supper Absorbent Polymer Effect on Available Water-Holding Capacity of Soils and Soil Water Retention Curve and Van Genuchten model Assessment. International Journal of Agronomy and Plant Production. 4(11): 2856-2865.

Suganya, S., Sivasamy, R., 2006. Moisture retention and cation exchange capacity of sandy soil as influenced by soil additives. J Appl. Sci. Res. 2:949–951.

Tejada, M., Garcia, C., Gonzalez, J.L., Hernandez, M.T., 2006. Use of organic amendment as a strategy for saline soil remediation: influence on the physical, chemical and biological properties of soil. Soil Biol. Biochem. 38, 1413–1421.

Umamaheshwarappa, P., Nachegowda, V., Murthy, P.V., 2005. Uptake of nitrogen, phosphorous, potassium and fruit size of cucumber Cv. Poinsette as influenced by different levels of NPK fertilizers. Karnataka J. Hort., 1(3): 76-80.

Valdez-Aguilar, L.A., Grieve, C.M., Poss, J.A., 2013. Response of lisian thus to irrigation with saline water: plant growth. J. Plant Nutr. 36, 1605–1614.

Vomocil, J. A., 1957. Measurements of soil bulk density and penetrability. A Review of Methods Adv. Agron., 9: 159–176.

Walker, D.J., Bernal, M.P., 2008. The effects of olive mill waste compost and poultry manure on the availability and plant uptake of nutrients in a highly saline soil. Bioresources Technology. 99, 396–403.

Wang, Z., Liu, Z., Zhang, Z., Liu, X., 2009. Subsurface drip irrigation scheduling for cucumber (Cucumissativus L.) grown in solar greenhouse based on 20 cm standard pan evaporation in Northeast China. Scientia Horticulturae, 123, 51–57.

Zhang, J., Chen, H., Li, P., Wang, A., 2006. Study on superabsorbent composite Preparation of polyacrylic acid/organo-attapulgite composite hydrogels and swelling behaviors in aqueous electrolyte solution. Macromol. Mat. Eng. 2006, 291, 1529–1538.

الملخص العربي

تأثير أستخدام محسنات التربة على أنتاجية، كفاءة أستخدام المياه والتوزيع الرطوبي في التربة لنبات الخيار المنزرع تحت نظام الري بالتنقيط التحت سطحي في التربة الرملية

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تم إجراء تجربة ميدانية في تربة رملية بأحد المزارع الخاصة بمحافظة الجيزة، خلال موسمين صيف متتاليين لعامي ٢٠١٤ و ٢٠١٥، وذلك لتقييم تأثير أستخدام محسنات التربة على أنتاجية وكفاءة أستخدام المياه لنبات الخيار تحت نظام الري بالتنقيط التحت سطحي. تم أستخدام ثلاث أنواع لخطوط الري بالتنقيط التحت سطحي هي (GR; GR anti-root; and T-tape) في حين كانت معاملات محسنات التربة المضافة للتربة الرملية هي (كومبوست؛ قش الأرز؛ بوليمر؛ والتربة الرملية بدون أي إضافات لمحسنات التربة).

أظهرت النتائج أن المعاملة الخاصة بإضافة الكومبوست مع خطوط الري بالتنقيط المضادة لإختراق الجذور قد حقق أعلى أنتاجية حيث كانت الأنتاجية أكبر بنسبة ٢٠.١٢٪ و ٣٤.٤٢٪ و ٥٧.٣١٪ مقارنة مع قش الأرز والبوليمر والتربة الرملية بدون أي إضافات على التوالي للموسم الأول، وبنسبة ١٦.٧٪ و٣٢.٧ و٥٣.٨٪ من قش الأرز والبوليمرات والتربة الرملية بدون أي إضافات على التوالي للموسم الثاني.

كانت كفاءة أستخدام المياه المياه تحت الكومبوست مع خطوط الري بالتنقيط المضادة لإختراق الجذور أكبر بنسبة ١٠.١٦٪ و ١١.٨٪ مقارنة مع الكومبوست مع GR والكومبوست مع T-tape على التوالي للموسم الأول، في حين كانت أكبر بنسبة ٨.٣٤٪ و ٩.٥٪ مقارنة مع الكومبوست مع GR والكومبوست مع T-tape على التوالي، للموسم الثاني .

تشير النتائج المتحصل عليها من هذه الدراسة إلى أن أنتاجية الخيار يمكن تحسينها تحت نظام الري بالتنقيط التحت سطحي باستخدام الكمبوست وخطوط التنقيط GR anti-root.

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