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EFFECT OF DRIP IRRIGATION ON PEACH TREES GROWN IN HEAVY CLAY SOILS.

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ABSTRACT

The present investigation was conducted during the two successive growing seasons 2013 and 2014 at a private farm located at Sidi Salem District , Kafr EL-Sheikh Governorate to study the effect of drip irrigation technique on peach trees productivity and some water relations in heavy clay soils .The investigation was carried out on "Florda prince " peach trees, seven years old budded on Nemaguard rootstock and spaced at 5×5 metre apart .The studied soil is heavy clay in texture. The selected trees were in a good health condition and uniform in both vegetative growth and fruit load. The used experimental design in this present is randomized complete blocks with three replicates .Twenty trees were selected in this study and divided randomly into four groups ; each group was subjected to one of the following irrigation treatments:I_1 (irrigation every 4 days with working hours ,5) ,I_2 (irrigation every 4 days with working hours ,4), I_3 (irrigation every 4 days with working hours ,3) and I_4 (irrigation every 4 days with working hours ,2)

The main results can be summarized as follows:

The highest overall mean values for water applied and water consumptive use for each irrigation and seasonal /fed. were recorded under irrigation treatment I_1 in comparison with other irrigation treatments I2, I3 and I4 and the values were 6.54 cm /fed./irrigation (274.68 m^3/fed./irrigation),78.48cm/fed./season (3296.16 m^3/fed./season) for water applied ,while for water consumptive use , the values are 5.64 cm/fed./ irrigation (236.89 m^3/fed./irrigation), 67.69 cm/fed./season (2842.67 m^3/fed./season). Meanwhile , the lowest overall mean values for the abovementioned studied parameters were recorded under irrigation treatment I 4 and the values for water applied were 2.69cm /fed./irrigation (113.02m^3/fed./irrigation) ,32.29cm/fed./ season (1356.27 m^3/fed./season) ,while ,for water consumptive use, the values were 2.14cm/fed./irrigation(89.58m^3/fed./irrigation),25.60cm/fed./season(1074.93m^3/fed./season).Generally , the overall mean values for water applied and consumptive use can be descended in order I1>I2>I3>I4.

Concerning, the effect of irrigation treatments on consumptive use efficiency (Ecu,%) , the highest overall mean value was recorded under irrigation treatment I1 and the value was 86.25%, but the lowest value was recorded under irrigation treatment I4 and the value is 79.27%. Regarding ,water productivity (WP) and productivity of irrigation water (PIW) ,the highest overall mean values are 4.98 and 3.95 kg/m^3 for WP and PIW ,respectively . On the other hand, the lowest overall mean values for WP and PIW were recorded under irrigation treatment I1 and the values are 2.0kg/m^3 and 1.74 kg fruits/m^3, respectively.

Concerning , yield ,fruit set ,total chlorophyll ,leaf area, total water content ,free water content, bound water content, leaf water deficit , NPK and Mg concentrations in peach leaves were significantly affected by irrigation treatments in the two growing seasons except ,pre-harvest fruit drop in the first season showed no significant effect with irrigation treatments .Generally ,the highest mean values for all the above mentioned studied parameters were recorded under irrigation treatment (I2)in the two

growing seasons ,except , total water content the highest mean values were recorded under irrigation treatment I1. Meanwhile , the highest mean values for bound water content ,leaf water deficit and pre-harvest fruit drop were recorded under irrigation treatment (I4) in the two growing seasons .

INTRODUCTION

Peach (Prunus persica L.Btsch) is one of the most important deciduous fruit trees grown in Egypt .The total planting area increased rapidly through the last three decades .It reached about (100623) feddans and total annual production (399416) tons of fruits according to (MALR , 2008) . Extension of the cultivated area is due to its highly economic value ,exporting potential and introducing new low chilling cultivars . "*Floreda prunce* " is an early cultivar ; it matures at end week of April under Egyptian conditions .It exhibited a high adaptation with the local environmental conditions . In peach , trees are bearing a normal commercial crop load during the final stage of rapid growth (Pavel and Dejang, 1993,Grossman and Dejong, 1995) .During this period , the sink demand of many rapidly growing fruits is greater than assimilate supply (Grossman and DeJong 1994).

In Egypt, water is the most critical factor in crop production . Rainfall is low with erratic distribution .Therefore , almost agricultural production is mainly dependent upon irrigation or which so, called irrigated agriculture. Water resources are limited and concentrated upon the Nile River which supplies Egypt with about 95% or more from fresh water . There are other water resources but they are still little in their magnitude such as ground water ,drainage water and rain fall . The Egyptian water budget from the Nile is 55.5 milliard cubic metre .Under limitation of water resources which face Egypt we should be done our best towards effective rationalization of irrigation on a farm level. The present share of water in Egypt is less than 1000 m3/ capita /year which is equivalent to the international standards of water poverty limit (El-Quosy, 1998) .Irrigation is the highest consuming sector of water .Water allocated to irrigation is about 85%from the total renewable water (48 milliard cubic metre) .So ,effective water management at the irrigation sector is the principal way towards the rationalization policy for the country . In this aspect, effective of farm irrigation management becomes a must

In Egypt maximizing water use efficiency (water productivity) by crops is the main issue in the agricultural sector to increase crop production in order to narrowing the food gap . One of the most important procedures to increase water productivity is using modernized irrigation system such as drip or trickle irrigation ,which should be used ,this system makes saving for irrigation water with about 30% of water as compared with surface irrigation system ,highly efficient implementation of drip system where it allows small but frequent application of water with minimum losses . In addition , it doesn't increase air humidity above crop canopy as much as sprinkler irrigation

Peach tree has strong shoot growth thus requiring substantial amount of irrigation water during the summer to sustain leaf productivity and yield . In

peach trees , irrigation water is required mainly during the 3rd fruit growth phase when fruit cells expand dramatically. Less water is required after fruit harvest, when , in the case of midseason ripening cultivars ,water needs can be almost half of that of the summer period . On the contrary ,most peach growers do not differentiate their irrigation strategies and continue to apply more than required water throughout the summer period .In addition, excess water during fruit growth can increase fruit size and yield ,but it may significantly reduce peach quality .Thus studies on water consumption by peach trees during the summer period and ways to monitor tree reaction to deficit irrigation are needed for the Mediterranean region .The research on peach irrigation has been reviewed by several authors (Berman and DeJong ,1996 and Naor *et al* .,2001).So, the main targets for this present work are to :

1-Investigate the water behavior of peach trees under drip irrigation system in heavy clay soils.

2-Study some water relations for this crop under using this technique in irrigation

3-Study the effect of using this system on yield and some water parameters.

MATERIALS AND METHODS

This investigation was carried out during the two successive growing seasons 2013and 2014 at a private farm located at Sidi Salem District, Kafr El-sheikh Governorate ,Egypt(The site is located at 31 o7 N latitude and 30 57 E longitude with an elevation of about 6 metres above mean sea level),to study the effect of drip irrigation system (drip irrigation treatments) on peach trees productivity , some water relations and also some water parameters of peach trees under heavy clay soil conditions .The investigation was carried out on " *Florda prince* " peach trees seven years old budded on Nemaguard rootstock spaced at 5×5 metre apart .The studied soil is heavy clay in texture .The selected trees were in a good health condition and uniform in both vegetative growth and fruit load .The used experimental design in this present study is randomized complete blocks with four replicates .Twenty trees were selected in this present study and divided randomly into four groups ; each group was subjected to one of the following irrigation treatments .

I_1= irrigation every 4 days with working hours ,5 (control) , like practice by the local farmers in the studied regions

I2= irrigation every 4 days with working hours ,4

I3= irrigation every 4 days with working hours , 3 and

I4= irrigation every 4 days with working hours , 2

All agricultural practices were carried out according to the crop and the area except the studied treatments which abovementioned before. Some chemical and physical characteristics for the experimental soil site were presented in Table (1) .Soil water constants for the experimental site were

illustrated in Table (2) .The meterological data of the studied period were presented in Table (3).

Table (1): The mean values of some soil chemical and physical characteristics for the experimental site in the two growing seasons.

Soil variable	Soil depth(cm)	
	0-30	**30-60**
pH(1:2.5)	8.2	8.1
EC(dS/m)	3.26	2.82
SAR	9.50	9.22
Soluble cations (meq/L)		
Na^+	21.15	19.17
K^+	0.36	0.29
Ca^{++}	6.85	5.93
Mg^{++}	3.92	3.41
Soluble anions(meq/L)		
Cl^-	14.52	13.27
HCO_3^-	5.67	5.18
CO_3^-	0.00	0.00
SO_4^{--}	12.09	10.30
Particle sized distribution(%)		
Sand	19.40	21.70
Silt	24.30	20.10
Clay	56.30	58.20
Textural grade	Clay	Clay

Table (2): The mean values of some soil water constants for the the experimental site in the two growing season

Siol depth (cm)	Field capacity(%)	Wilting point(%)	Available water(%)	Bulk density(g/cm3)
0-15	45.51	24.47	21.04	1.15
15-30	40.62	21.16	19.46	1.27
30-45	37.90	19.33	18.57	1.32
45-60	35.97	18.84	17.13	1.39
Average	40.00	20.95	19.05	1.28

Table (3): Mean of some meterological data for KafrEl-Sheikh area during the two growing seasons

nth	T (C°)			RH%			W_S	Pan Evap.	Rain
	Max	Min	Mean	Max	Min	mean	m/sec	Mm/day	mm
	Season 2013 *								
Jan	19.22	7.62	13.42	91.06	65.35	78.21	0.52	1.99	78.74
Feb.	20.68	8.88	14.78	89.89	64.04	76.97	0.73	2.89	------
Mar.	24.56	12.45	18.51	79.48	50.84	65.16	1.03	4.46	-------
April.	26.04	15.87	20.96	74.20	43.90	59.05	1.11	5.30	8.40
May	31.43	21.85	26.64	75.03	45.78	60.41	1.20	6.35	0.00
June	32.44	23.97	28.21	74.63	51.27	62.95	1.34	6.61	0.00
July	32.32	24.31	28.31	79.57	54.70	97.14	1.28	6.11	.....
Agus.	33.79	24.72	29.29	83.63	60.52	72.08	1.04	5.13	------
Sep.	32.50	22.93	27.72	81.00	56.60	68.80	1.04	3.82	-------
Oct.	27.79	19.42	23.61	76.23	57.36	66.80	1.26	2.87	.....
Nov.	25.39	15.14	20.27	87.00	64.43	75.72	0.80	2.28	0.00
Dec.	19.64	8.51	14.06	92.07	67.61	79.84	0.61	4.15	81.90
	Season 2014*								
Jan	20.34	7.55	13.95	93.69	70.55	80.55	0.54	0.61	20.70
Feb.	20.64	8.19	14.42	91.90	67.15	79.53	0.79	2.52	16.50
Mar.	22.94	11.71	17.33	86.10	56.80	71.45	0.96	3.14	26.20
April.	27.50	15.53	21.52	81.80	49.80	65.80	1.07	4.91	20.20
May	30.47	19.57	25.02	77.20	48.60	62.90	1.14	5.87	0.00
June	32.65	20.60	26.63	86.23	52.30	69.27	0.95	6.56	0.00
July	33.15	23.64	28.40	83.19	55.11	69.15	1.13	7.73	.....
Agus.	34.10	21.80	27.95	92.40	53.50	72.95	1.15	8.14	------
Sep.	32.49	20.76	26.63	87.57	52.20	69.89	1.03	6.65	-------
Oct.	29.75	18.75	24.25	80.92	53.39	67.16	0.95	4.51	.....
Nov.	24.30	13.79	19.05	87.80	60.50	74.15	0.78	2.77	24.60
Dec.	22.27	9.72	16.00	88.60	63.50	76.05	0.53	1.72	5.70

*Source: meterological station at Sakha 31 07` Nlatitude, 30 57 E longitude & with an elevation of about 6 metres above mean sea level (MSL).

Some soil physical properties , soil waterconstants and chemical properties:-

The studied chemical characteristics such as soil reaction (PH) values were determined in 1:2.5 soil water suspension (Jackson ,1973) .Total soluble salts were measured by electrical conductivity (EC) apparatus in the saturated soil paste extract (Jackson ,1973).Soluble cations and anions (Ca^{++}, Mg^{++},Na^{+} ,K^{+} ,CO_3^{-},HCO_3^{-} and Cl^{-} as meq/L) were determined in soil paste extract(Jackson ,1973) So_4^{-} as meq/L was calculated by the difference between cation and anions . Sodium adsorption ratio (SAR) was calculated according to this equation :

$$SAR=\frac{Na^{+}(meq/l)}{\sqrt{(ca^{++}+Mg^{++})/2}}$$

Where : Na^{+}, ca^{++} and Mg^{++} are soluble sodium ,calcium and magnesium as meq/L, respectively .

Other chemical characteristics were determined and calculated according to (Black, 1983) .The studied physical characteristics and soil water constants such as mechanical analysis were determined according to the (Klute,1986) .Available soil moisture (available water) was calculated as the difference between the field capacity and permanent wilting point .Total porosity of the soil was calculated according to this equation .

$$\text{Total porosity} = (1 - \frac{\text{Bulk density}}{\text{Real density}}) \times 100$$

Note :real density = particle density =2.65Mg/$m^3$for mineral soil.

The drip irrigation system consists of a pumped unit which contains a pump ,control unit ,groups of pipes which differ in its diameter and distribution lines . The control unit of the system contains a venture injector (25.4 mm),fertilizer tank ,disk filters ,control values and a water flow meter .Distribution lines consists of polyethylene (PE) pipes manifolds (display and discharge) lateral of 16mm in diameter and 40 m in length had in line emitters spaced 0.5m apart ,each delivering 4Lh^{-1} at a pressure of 1 bar . Drip irrigation lines were spaced 0.8m apart equally spaced between every other row of peach .Water was applied from a pressurized hydrant and filtered through gravel and re-filtered through disk filters .The texture of the experimental field soil is heavy clay .Water table level is about 150 cm.

Data collection

1-Irrigation water applied (IWa,cm&m^3/fed)

The amount of irrigation water applied at each irrigation was measured by using flowmeter .Then seasonal amount of irrigation water applied was calculated as cm&m^3/fed

2-water consumptive use (Cu,m^3/fed):

To compute the actual consumed water of the growing plants ,soil moisture percentage was determined (on weight basis)before and after each irrigation as well as at harvesting .Soil samples were taken from successive layers in the effective root zone (0-15, 15-30 ,30-45 and 45-60 cm.) .This is a direct method for calculating water consumptive use based on soil moisture depletion (SMD) or actual crop water consumed (ETc) as stated by(Hansen *et al.*,1979).

$$CU = SMD = \sum_{i=1}^{i=4} \frac{Q2 - Q1}{100} \times Dbi \times Di$$

Where:

CU =Water consumptive use(cm) . in the effective root zone of 60 cm .depth

SMD= soil moisture depletion .

i =number of soil layers (1-4),

Dbi =Bulk density (g/cm^3) of the layer,

D I = soil layer thickness(15cm),

Q_1 = soil moisture percentage before the next irrigation, and

Q_2 =soil moisture percentage 48 hours after irrigation

3- Consumptive use efficiency (Ecu %):

Values of water consumptive use efficiency (Ecu %) was calculated according to(Bos ,1980) equation:

Ecu = (ETc/IWa)×100

Where

Ecu =consumptive use efficiency (%)

ETc =total evapotranspirtion ≈ consumptive (m^3/fed.) use and,

IWa = irrigation water applied to the field plot (m^3/fed).

4- Water productivity (WP,kg/m^3).

Water productivity is generally defined as crop yield per cubic metre of water consumption .Water productivity is defined as crop production per unit amount of water used (Molden ,1997) .Concept of water productivity in agriculture production system is focused on producing more food with the same water resources or producing the same amount of food with less water resources .It was calculated according to (Ali *et al.*,2007):

WP=Y/ET

Where :

WP =Water productivity (kg fruit /m^3)

Y=Fruit yield (kg/fed.) and

ET= Total water consumption ≈ evapotranspiration~ consumptive use (m^3/fed)

5- Productivity of irrigation water (PIW,kg/m^3)

productivity of irrigation water (PIW) as calculated according to (Ali *et al.*,2007):

PIW=Y/IWa

Where :

PIW= Productivity of irrigation water (kg fruit /m^3)

Y=fruit yield (kg/fed.) and

IWa = Irrigation Water applied to the field plot (m^3 /fed.)

Yield ,some yield attributes and some water parameters :

1-Leaf area :

Leaf area (cm^2) was measured by using Li-core-3100 Area meter.

2-water relation studies of leaf:

Leaf samples were taken before irrigation for analysis. The samples were collected usually at sunrise and taken to the laboratory in will tight plastic bags wrapped with moist cloth sheet . These prepared samples were used as described later for the following determinations according to the method described by(Gosev. ,1960) , as modified by(.Koshnirinko et al, 1970) for fruit trees during two seasons as follow :

Total water content:

Total water content was estimated by drying a known weight of the cleaned fresh green leaves in glass vials in an oven adjusted at 85 °C until constant weight ,total water content was calculated by the equation :

$$\text{Total water content (\%)} = = 100 \frac{\text{Fresh weight} - \text{dry weight}}{\text{Fresh weight}} \times$$

Free water content :

Free water content was estimated by putting a known weight of cleaned green fresh leaves in a known volume of 60% sucrose solution for 2 hours ,using "Penicillin " bottles . The initial and final concentration of the sucrose solution was measured by Abbi refractometer . Free water content was calculated by the equation :

$$X = \frac{A \times B}{C \times D} \times 100$$

Where :
X=The free water content of the leaves.
A=solution weight.
B= The difference between the initial and final concentration of the sucrose solution.
C= The fresh weight of the leaves
D= The final concentration of sucrose solution .

Bound water content :

Bound water content was calculated by subtracting free water content from total water content in each sample .

water deficit :

10 discs about 1 cm^2 in diameter were cut from the mature leaves , weighted ,flooded into distilled water for some hours until they attain equilibrium ,reweighed and oven dried at 85°C for 24 hours to reach a constant weight .Water deficit were calculated as (Barrs,1968) :

$$\text{Water deficit} = \frac{\text{Turgid weight} - \text{field weight}}{\text{Turgid weight} - \text{oven dry weight}} \times 100$$

3-Chlorophyll determination :

For Chlorophyll determination ,discs about 1 cm^2 of the fresh leaf samples were dipped in 10 ml N,N-Dimethyl Formamide solution for 48 hours at 4°C in the dark .Chlorophyll concentration (as mg/cm^2) fresh leaf was measured in the extraction colorimetrically by using UV/visible spectrophotometer-LKB-Biochrom 4050 at 664 nm for chlorophyll-a and 647 nm for chlorophyll-b according to(Moran,1982), chlorophyll was calculated (as mg/cm^2) by using the following mathematic manipulation :

Ch1-a= 12.64 A_{664} - 2.99A_{647}
Ch1-b= 5.6 A_{664} + 23.26A_{647}

$$\text{Chl. Concentration } (mg/cm2) = \text{ch1.a or b} \times \frac{\text{Solution volume}}{\text{Discs area}}$$

4- Leaf mineral content :

Leaf samples consisted of 10 leaves each were collected from the tested peach trees on late May of both seasons . Leaf samples were taken from the middle of the tagged shoots, washed several times with tap water, rinsed into distilled water and dried at 70 c to a constant weight .The dried leaves were ground and digested with sulphoric acid and hydrogen peroxide according to the method described by (Evenhuis and DeWaard, 1980). Suitable quantities were taken for mineral elements determination. Nitrogen

and Phosphorus were determined colorimetrically according to (Evenhuis, 1976) and (Murphy and Riley, 1962), respectively. As for potassium was determined by flame photometer while Magnesium was determined according to (Chapman and Pratt, 1961).

5-Fruit set and fruit drop percentages:

The total number of flowers on each limb was counted at full bloom then the number of fruit set was counted on the same limbs after one month from full bloom .Fruit set percentage was calculated as follows:

$$\text{Fruit set percentage} = \frac{\text{Number of developing fruitlets}}{\text{Total number of flowers}} \times 100$$

Furthermore number of dropped fruits were recorded till commercial harvesting time ,then estimated as a percentage on the basis of initial number of set fruitlets according to this equation:

$$\text{Pre} - \text{harvest fruit drop percentage} = \frac{\text{Number of dropped fruit lets}}{\text{Initial No.of set fruit lets}} \times 100$$

6-Yield :

The average yield per tree in kgs for each treatment was determined at the harvesting time – at maturity stage. Furthermore , the yield per fed in ton was estimated by multiplying number of trees /fed. and average tree yield

Statistical analysis:

Statistical analysis of the studied experiment was randomized complete block design and all data obtained throughout this present work were tested by analysis of variance (Little and Hills ,1998) and L.S.D test at 0.05 level was used for comparing between averages.

RESULTS AND DISCUSSION.

Effect of drip irrigation treatments on:

1-Irrigation water applied (IWa,cm &m^3/fed) :

Tabulated data in table (4) clearly illustrated that, irrigation water applied was greatly affected by irrigation treatments .The highest overall mean values through the two growing seasons were recorded under irrigation treatment I_1 (irrigation every 4 days with working hours,5) and the values are 6.54 cm/fed /irrigation (274.68m^3/fed /irrigation) ,78.48 cm /fed./season (3296.16m^3/fed./ season) . Meanwhile ,the lowest overall mean values through the two growing seasons were recorded under irrigation treatment I_4 (water stress condition ,irrigation every 4 days with working hours ,2) and the values were 2.69 cm/fed ./irrigation (113.02 m^3 /fed./ irrigation), 32.29 cm/fed./ season (1356.27 m^3 /fed./ season). Generally ,the overall mean values for irrigation water applied can be descended in order $I_1>I_2>I_3>I_4$ and the values were 78.48cm/fed./ season (3296.16 m3./fed./season), 62.97cm/fed/season (2644.49 m^3/fed/season) ,47.27cm.fed/season (1985.26

m^3./fed. /season) and 32.29 cm/fed./season(1356.27 m^3./fed /seasons) ,respectively . Increasing the overall mean values for irrigation water applied under irrigation treatment I_1 in comparison with other irrigation treatments I_2,I_3 and I_4 could be attributed to increasing irrigation timing and hence increasing irrigation water applied . These results are in a great harmony with those reported by (Sidky, *et al.,* 1998) on Roselle plants (EL-Sabach and Aggag, 2003) on *"Anna" apple* ,(Younis et al .,2009) on Roselle plants , (Moursi *et al.,* 2010) on sunflower and(Mikhael *et al.,* 2010) ,who concluded that ,the amount of irrigation water applied for "Dessert Red" peach trees under the same studied area were clearly affected by irrigation treatments ,where the highest values were recorded under irrigated at 80% of field capacity in comparison with other treatments :70 and 60% of field capacity . Also ,these findings are in the same harmony with those reported by(Garcio and Brunton, 2013) on peach and (Moursie *et al.,* 2014) on *faba bean*

2-Water consumptive use (cu,cm&m^3/fed):-

Data in Table (5) clearly showed that, the overall mean values for water consumptive use (cu) were clearly affected by irrigation treatments ,where ,the highest values were recorded under irrigation treatment I_1 and the values were 5.64 cm / fed. / irrigation (236.89m^3/fed./irrigation),67.69cm/fed./season (2842.67m^3/fed./season).

On the other hand ,the lowest overall mean values were recorded under irrigation I_4 and the values are 2.14 cm/fed./irrigation (89.58m^3/fed./irrigation),25.60 cm/fed./season (1074.93m^3/fed./season).

Generally , the mean values of water consumptive use can be descended in order $I_1>I_2>I_3>I_4$ in the two growing seasons .Increasing the mean values of water consumptive use under irrigation treatment I_1 in comparison with other irrigation treatments I_2,$I_3$and I_4 may be due to increasing the amount of irrigation water applied and hence increasing the amount of fertilizers application through (fertigation process) ,also ,increasing amount of irrigation water applied leads to increasing availability of soil nutrients .

Therefore ,increasing uptake rate of these nutrients and so forming strong and healthy trees with a condensed vegetative cover .Consequently, the canopy area which exposes to sunlight increases .So, the rate of transpiration through vegetative cover increases .Transpiration considers one of the main components of water consumptive use in addition ,evaporation from the soil surface .So ,under the conditions of irrigation treatment I_1 the values of water consumptive use increases .These results are in a great harmony with those obtained by (Younis, *et al.,* 2009) ,(Moursi *et al.,*2010) ,(Garcio and Brunton ,2013) and (Moursi *et al.,*2014)

Table(4):Effect of irrigation treatments on amount of seasonal water applied for peach trees under drip irrigation system in the two growing seasons:

Irrigation treatments (I)	1st growing season				2nd growing season				The overall mean values through the two growing seasons			
	Cm/fed./ irrigation	m^3/fed./ irrigation	Cm/fed./ season	m^3/fed./ season	Cm/fed./ Irrigation	m^3/fed./ irrigation	Cm/fed./ season	m^3/fed./ season	Cm/fed./ irrigation	m^3/fed./ irrigation	Cm/fed./ season	m^3/fed./ season
I_1	6.48	272.16	77.76	3265.92	6.60	277.20	79.20	3326.40	6.54	274.68	78.48	3296.16
I_2	5.18	217.73	62.21	2612.74	5.31	223.02	63.72	2676.24	5.25	220.38	62.97	2644.49
I_3	3.89	163.30	46.66	1959.55	3.99	167.58	47.88	2010.96	3.94	165.44	47.27	1985.26
I_4	2.59	108.86	31.10	1306.37	2.79	117.18	33.48	1406.16	2.69	113.02	32.29	1356.27

Table(5)Effect of irrigation treatments on water consumptive use for peach trees under drip irrigation system in the two growing seasons.

Irrigation treatments (I)	1st growing season				2nd growing season				The overall mean values through the two growing seasons			
	Cm/fed./ irrigation	m^3/fed./ irrigation	Cm/fed./ season	m^3/fed./ season	Cm/fed./ Irrigation	m^3/fed./ irrigation	Cm/fed./ season	m^3/fed./ season	Cm/fed./ irrigation	m^3/fed./ irrigation	Cm/fed./ season	m^3/fed./ season
I_1	5.60	235.22	67.21	2822.62	5.68	238.56	68.16	2862.72	5.64	236.89	67.69	2842.67
I_2	4.43	186.01	53.15	2232.10	4.50	189.00	54.00	2268.00	4.47	187.57	53.58	2250.05
I_3	3.24	135.96	38.85	1631.57	3.33	139.86	40.01	1680.60	3.29	137.91	39.43	1656.09
I4	2.07	86.75	24.79	1041.05	2.20	92.40	26.40	1108.80	2.14	89.58	25.60	1074.93

3-Irrigation water efficiencies:

The studied irrigation efficiencies are consumptive use efficiency (Ecu%), water productivity (WP,kg/m^3) and productivity of irrigation water (PIW,kg/m^3).Tabulated data in Table (6) clearly illustrated that ,the overall mean values through the two growing seasons for consumptive use efficiency ,water productivity and productivity of irrigation water were greatly affected by irrigation treatments (amount of irrigation water applied) .Regarding ,the values of consumptive use efficiency (Ecu%),the highest overall mean values were recorded under irrigation treatment I_1 (Traditional irrigation) and the value is 86.25%. Meanwhile ,the lowest overall mean value was recorded under irrigation treatment I_4 (The least amount of irrigation water applied ,water stress conditions) and the value is 79.27% .Generally ,the overall mean values for consumptive use efficiency can be descended in order $I_1>I_2>I_3>I_4$. Increasing the overall mean values for consumptive use efficiency under the conditions of irrigation treatment I_1(Traditional irrigation) may be due to increasing the amount of water consumptive use in comparison with other irrigation treatments I_2 ,I_3 and I_4 which exposed to water stress during the growing season . These results are in the same line with those reported by (Younis, *et al.*,2009) ,(Mikhael, *et al.*, 2010) and (Moursi, *et al.*,2014) .

Concerning ,water productivity (WP) and productivity of irrigation water (PIW) .The overall mean values for the abovementioned two studied parameters were highly affected by irrigation treatments (amount of irrigation water applied) as clearly shown in Table (6) ,the highest overall mean values for WP and PIW were recorded under irrigation treatment I_4 (Water stress conditions) and the values are 4.98 kg/m^3 and 3.95 kg/m^3 for WP and PIW ,respectively. On the contrary ,the lowest overall mean values were recorded under irrigation treatment I_1(Tradition irrigation non- stressed condition) and the values are 2.01 kg/m^3 and 1.74 kg/m^3 for WP and PIW ,respectively .Generally ,the overall mean values for WP and PIW can be descended in order $I_4>I_3>I_2>I_1$ and the values for WP are 4.98,3.42, 2.57 and 2.01 kg/m^3 ,respectively .The corresponding values for PIW are 3.95 ,2.85, 2.18 and 1.74 kg/m^3 ,respectively .This means that ,under water stress condition the values of WP and PIW were increased in comparison with non-stressed conditions (Tradition irrigation ,like practice by local farmers in the studied area) which recorded the lowest values .Increasing the overall mean values for WP and PIW under water stress condition in comparison with non-stressed ones may be attributed to decreasing amount of water consumptive use and irrigation water applied under stressed treatments .These results are in a great harmony with those reported by(Ibrahim and Abd El-samad, 2009) on "Manfalouty " pomegranate .They indicated that a gradual decrease in water use efficiency (water productivity) values due to increase the a mount of water applied and consumptive use .Also ,these results are in a great agreement with those obtained by (Mikhael, *et al.*, 2010) on peach trees "Dessert Red" who reported that ,the highest significant values for field water use efficiency (productivity of irrigation water) were recorded under irrigation trees at 70% of field capacity (moderate irrigation regime) in both seasons

followed in descending order by those irrigated at 60% and 80% of field capacity . The same finding were found by (El-Abd ,*et al.*, 2012) on "Navel orange trees " and (Garcio and Brunton, *et al.*, 2013) on peach trees and (Moursi, *et al.*, 2014) on Faba bean

Table (6) Effect of irrigation treatments on consumptive use efficiency (Ecu,%) ,water productivity (WP, kg/m^3) and productivity of irrigation water (PIW, kg/m^3) for peach trees under drip irrigation system in the two growing seasons .

Irrigation Treatments (I)	1st growing season			2nd growing season			The overall mean values through the two growing seasons		
	ECU%	WP, kg/m^3	PIW, kg/m^3	ECU%	WP, kg/m^3	PIW, kg/m^3	ECU%	WP, kg/m^3	PIW, kg/m^3
I_1	86.43	2.06	1.78	86.06	1.96	1.69	86.25	2.01	1.74
I_2	85.43	2.61	2.23	84.75	2.52	2.13	85.09	2.57	2.18
I_3	83.26	3.51	2.92	83.57	3.32	2.77	83.42	3.42	2.85
I_4	79.69	5.21	4.15	78.85	4.74	3.74	79.27	4.98	3.95

4-Water relations determinations :

Water relations determinations here mean :Total water content (T.W.C%), Free water content (F.W.C%), Bound water content (B.W.C%) and Leaf water deficit (L.W.D%) presented data in Table (7) clearly illustrated that ,all the above mentioned studied water relations determinations were significantly affected by irrigation treatments (amount of irrigation water applied) .Concerning ,total water content and free water content in leaf tissues of "Florda prince " peach trees were highly significantly decreased by reducing amount of irrigation water applied ,where ,the highest mean values in the two growing seasons were recorded under irrigation treatment I_1 (Tradition irrigation) and the values are 70.91 % and 73.74 % for total water content and 48.87% and 51.71 % for free water content in the first and second growing seasons ,respectively .Meanwhile ,the lowest mean values were recorded under irrigation treatment I_4 and the values are 65.87% and 69.96%for total water content and 41.49 % and 45.56% for free water content in the first and second growing seasons ,respectively .Generally the mean values of total water content and free water content can be descended in order $I_1>I_2>I_3>I_4$ in the two growing seasons .Increasing the mean values of total water content and free water content under irrigation treatment I_1 in comparison with other irrigation treatments I_2,I_3 and I_4 could be attributed to increasing the amount of irrigation water applied under the conditions of this treatment and hence, increasing water availability for trees .Consequently, increasing the amount of water absorption by trees and so, increasing the tissues of leaf contents from total water content and free water content . Similar results were obtained by(Soliman ,2003) on young deciduous fruit trees ,who found that total and free water contents were significantly decreased under water deficit conditions .Also these findings are in a great

harmony with those reported by (Mikhael, *et al.,* 2010) who concluded that total and free water contents in leaf tissues of "Dessert Red " peach trees were significantly decreased by reducing irrigation rate from 80% to 60% of field capacity .Low irrigation regime recorded the least values .

Regarding ,bound water content and leaf water deficit ,data in the same Table clearly showed that ,both bound water content and leaf water deficit were significantly affected by irrigation treatments .The values of the two studied parameters were significantly increased by reducing irrigation rate (amount of irrigation water applied).The highest mean values for the two parameters were recorded under irrigation treatment I_4 (strict water deficit) and the values are 24.38% and 24.40% for bound water content and 16.93% and 15.00% for leaf water deficit in the first and second growing seasons ,respectively. Meanwhile ,the lowest mean values for bound water content and leaf water deficit were recorded under non-stressed treatments I_1,I_2 and I_3 comparing with stressed one I_4 .Increasing the mean values of bound water content and leaf water deficit under irrigation treatment I_4 may be due to decreasing amount of irrigation water applied and hence, decreasing water availability and so, decreasing water absorption by plants .This increment in bound water content and leaf water deficit under deficit of soil moisture could be attributed to reduction in vegetative growth which accumulates organic substances . Thes results are in a great harmony with those obtained by (El-Sanhoury, 2003) and (Soliman, 2003) on different fruit trees .They found that ,bound water content and osmotic pressure of cell sap significantly increased under water stress conditions .Also ,these findings are in a great agreement with those reported by (Mikhael ,*et al.,* 2010) who revealed that ,bound water content and osmotic pressure of the cell sap of peach leaves had been recorded a reversible behavior to total and free water contents as influenced by irrigation .

Table (7): Effect of irrigation treatments on some water relations determinations for peach trees under drip irrigation system in the two growing seasons

Irrigation Treatments (I)	1st growing season				2nd growing season			
	Total water content (%)	Free water content (%)	Bound water content (%)	Leaf water deficit (%)	Total water content (%)	Free water content (%)	Bound water content (%)	Leaf water deficit (%)
I_1	70.91	48.87	22.04	14.27	73.74	51.71	22.03	13.22
I_2	70.25	48.70	21.55	14.40	73.55	50.49	23.06	13.45
I_3	69.72	47.49	22.23	14.82	72.00	50.82	21.18	13.45
I_4	65.87	41.49	24.38	16.93	69.96	45.56	24.40	15.00
F.test LSD at 5%	0.3464	0.7952	1.0268	0.1898	0.0798	0.7784	0.8826	0.0569

5-Total leaf chlorophyll content and leaf area :

Tabulated data in Table (8) clearly declared that, the values of chl.A ,B and total leaf chlorophyll content and leaf area were greatly affected by irrigation treatments .Regarding the values of total leaf chlorophyll content were significantly affected by irrigation treatments I_1,I_2,I_3 and I_4 .The highest values were recorded under irrigation treatment $I_2$and the values are 38.13 and 32.79 mg/cm^2 in the first and second growing seasons ,respectively

.Meanwhile ,the lowest values were recorded under irrigation treatment I_4 and the values are 32.05 and 28.25 mg/cm^2 in the first and second growing seasons ,respectively . Increasing the values of total leaf chlorophyll content under irrigation treatment I_2 in comparison with other irrigation treatments I_1 and other treatments I_3 and I_4 which exposed to water stress through the growing season. This increment under the condition of irrigation treatment I_2 may be attributed to increasing the amount of irrigation water applied

Therefore ,increasing leaf area which exposes to sun light .Consequently ,increasing photosynthesis rate in the leaf and so, increasing total leaf chlorophyll content .These results exhibit positive correlation between soil moisture level and total leaf chlorophyll content .Also ,this increment in total leaf chlorophyll content could be attributed to increasing the uptake of macronutrients especially N and Mg elements via the root as consequence of improved soil moisture content ,whereas N and Mg nutrients are necessary for chlorophyll synthesis (Mengle and Kirkby 1982) .Such results are in the same line with those obtained by (Mikael ,2007), who found that ,decrease the amount of irrigation water caused a significant decrease in total leaf chlorophyll content .The same finding were reported by (Mikhael, *et al.,* 2010) . Concerning ,leaf area ,the values of leaf area were significantly affected by irrigation treatments. The highest values were recorded under irrigation treatment $I_2$and the values are 29.89 and 34.48 cm^2 in the first and second growing seasons ,respectively .On the other hand ,the lowest values were recorded under irrigation treatment I_4 and the values are 25.94 and 25.89 cm^2 in the first and second growing seasons ,respectively .Increasing the values of leaf area under irrigation treatment I_2 in comparison with other irrigation treatments I_1,I_3 and I_4,may be due to increasing amount of irrigation water applied (moderate water applied) and hence ,increasing availability of nutrients .So ,increasing uptake rate of these nutrients .Consequently, forming strong and healthy plants with a good and thick canopy. Therefore ,increasing leaf area under I_2. But under I_1,there is excessive in water applied (traditional method) which leads to leaching nutrients .Consequently ,decreasing the amount of nutrients uptake by plants and hence forming weak plants with thin leaf area .The same effect appears under irrigation treatments $I_3$and I_4 which exposed to water stress.

Table (8) : Effect of irrigation treatments on chlorophyll A&B and total chlorophyll and leaf area (cm^2) for peach trees under drip irrigation system in the two growing seasons.

Irrigation Treatments (I)	1st growing season				2nd growing season			
	Chlorophyll (A) (mg/cm^2)	Chlorophyll (B) (mg/cm^2)	Total chlorophyll (mg/cm^2)	Leaf area (cm^2)	Chlorophyll (A)(mg/cm^2)	Chlorophyll (B) (mg/cm^2)	Total chlorophyll (mg/cm^2)	Leaf area (cm^2)
I_1	21.94	13.82	35.76	29.79	21.55	10.13	31.68	34.46
I_2	22.69	15.44	38.13	29.89	21.31	11.48	32.79	34.48
I_3	20.35	13.69	34.04	29.34	18.89	9.95	28.84	33.25
I_4	19.50	12.55	32.05	25.94	20.32	7.93	28.25	25.89
F.test LSD at 5%	NS	1.449	2.9701	1.6493	NS	0.5078	2.5018	0.9936

6 -Nutritional status (concentration of NPK and Mg in peach leaf:

NPK and Mg consider macronutrients for plants ,this means that plants require a large amount from these nutrients to complete their life cycle to avoid any drastic effect on plants productivity in case of decreasing the amount of these nutrients application .Presented data in Table (9) clearly illustrated that ,the values of NPK and Mg concentrations in peach leaf were significantly affected by irrigation treatments in the two growing seasons .The highest values for concentration of these nutrients were recorded under irrigation treatment I_2in the two growing seasons and the values are 2.80 and 2.66% for N, 0.228 and 0.261% for P, 1.75 and 1.60% for K and 0.75 and 0.73 % for Mg in the first and second growing seasons ,respectively .Meanwhile , the lowest values for the abovementioned nutrients were recorded under irrigation treatment $I_4$and the values are 2.36 and 2.40 % for N, 0.207 and 0.217% for P,1.42 and 1.45 % for K and 0.68 and 0.65 % for Mg in the first and second growing seasons ,respectively .These results could be led to a conclusion that nutrients uptake was retarded under water stress conditions ,where the root failed to absorb the accumulative valuable nutrient elements .Moreover ,decreasing amount of water applied caused a reduction in leaf mineral contents due to reducing active rooting as an indirect influence (AbdEl-Messeih and EL-Gendy ,2004b) .These results were confirmed by many previous investigators such as (Nandwal, *et al.,* 1996) ,(Mikhael, 2007) and (Mikhael, *et al.,* 2010) .They concluded that ,leaf mineral content significantly declined under drought conditions.

Table (9) Effect of irrigation treatments on nitrogen (N) ,phosphorus (P) ,potassium (K) and Magnesium (Mg) concentration in leaves of peach in the two growing seasons :

Irrigation Treatments (I)	1st growing season				2nd growing season			
	N(%)	P(%)	K(%)	Mg(%)	N(%)	P(%)	K(%)	Mg(%)
I_1	2.50	0.218	1.69	0.75	2.64	0.250	1.50	0.69
I_2	2.80	0.228	1.75	0.75	2.66	0.261	1.60	0.73
I_3	2.66	0.218	1.64	0.73	2.48	0.250	1.47	0.67
I_4	2.36	0.207	1.42	0.68	2.40	0.217	1.45	0.65
F.test LSD at 5%	0.0420	0.0009	0.0310	0.0268	0.0310	0.0006	0.0759	0.0335

7- Fruit set (%) ,pre-harvest drop (%) ,yield (kg/tree) and yield (ton /fed) for peach " Florda prunce cv":

Tabulated data in Table (10) clearly showed that ,the values of fruit set and yield (kg/tree) and yield (ton /fed.) were significantly affected by irrigation treatments in the two growing seasons . The highest values for fruit set and yield were recorded under irrigation treatments I_2 in the two growing seasons and the values are 85.4 and 85.1% for fruit set and 34.70 and 34.00 kg/tree and 5.8297 and 5.7120 ton /fed for yield in the first and second growing seasons ,respectively .Meanwhile ,the lowest values for the two abovementioned studied parameters were recorded under irrigation treatment I_4 (water stress conditions) and the values were 79.5 and 79.0 % for fruit set and 32.30 and 31.30 kg/ tree and 5.4263 and 5.2587 ton /fed for yield, in the first and second growing seasons ,respectively .Regarding ,pre-harvest fruit drop , the highest values were recorded under irrigation

treatment I_4 in the two growing seasons and the values were 21.60 and 21.20% in the first and second growing seasons ,respectively .Increasing yield and fruit set under irrigation treatment I_2 in comparison with other irrigation treatments I_1,I_3 and I_4 could be attributed to the increment of the number of fruit /tree and the improvement of fruit weight with less pre-harvest fruit drop percentage. These results are in a great harmony with those obtained by(Mikhael, *et al.,* 2010) .

Table (10) :Effect of drip irrigation on fruit set (%) ,pre-harvest fruit drop (%), yield (kg/tree) and yield (ton/fed.) for peach "Florda prunce cv."in the two growing seasons.

Irrigation Treatments (I)	1st growing season				2nd growing season			
	Fruit set %	Pre-harvest fruit drop (%)	Yield (kg/tree)	Yield (ton /f)	Fruit set %	Pre-harvest fruit drop (%)	Yield (kg/tree)	Yield (ton /f)
I_1	85.3	20.30	34.60	5.8130	84.3	20.30	33.40	5.6113
I_2	85.4	20.10	34.70	5.8297	85.1	19.30	34.00	5.7120
I_3	84.0	20.70	34.10	5.7287	83.8	20.40	33.20	5.5773
I_4	79.5	21.60	32.30	5.4263	79.0	21.20	31.30	5.2587
F.test LSD at 5%	1.0313	NS	0.3001	0.0506	1.8124	0.7120	0.4042	0.0678

Conclusion and Recommendation

Under the condition of water shortage in Egypt, because it considers a tail end country of the Nile basin and the importance of peach crop as a source to bring a hard currency by exporting . Under the condition of Egypt and desire of water policy makers to apply the modernized irrigation systems (pressurized irrigation technique like drip or trickle irrigation) in the North Middle Nile Delta region (studied region). So, this study recommends that peach trees can be irrigated under drip irrigation system in the studied area every 4 days with 4 hours (I_2) to give the highest productivity through increasing fruit set and yield and decreasing pre-harvest fruit drop .In case of, water scarcity conditions number of irrigation hours can be decreased till 2 or 3 every 4 days.This may be led to little decrease in yield but high increasing in both water (PIW) in comparison with other treatments which received the highest amount of water applied and led to a slight increase in yield but decreasing both water productivity and productivity of irrigation water.

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تأثير الري بالتنقيط على أشجار الخوخ النامية في الاراضى الطينية الثقيلة

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الدراسة الحالية نفذت خلال موسمي نمو ٢٠١٣و ٢٠١٤ وذلك في مزرعة خاصة بمركز سيدي سالم -محافظة كفر الشيخ وذلك بهدف دراسة تأثيرنظام الري بالتنقيط علىانتاجية أشجار الخوخ وبعض العلاقات المائية تحت ظروف الأراضي الطينية الثقيلة – الدراسة نفذت على أشجار الخوخ صن (Florda prince) وكان عمر الأشجار ٧ سنوات ومسافات الزراعة ٥×٥ م .الأشجار التي تم اختيارها كانت ذات نمو جيد من حيث المجموع الخضري وكذلك الحمولة الثمرية . التصميم الأحصائى المستخدم فى الدراسة القطاعات كاملة العشوائية فى ثلاثة مكررات .عشرون شجرة تم اختيارها وقسمت إلى أربع مجموعات كل مجموعة نفذت عليها واحدة من معاملات الرى الأتية:

I_1 (ري كل ٤ ايام وساعات تشغيل ٥ ساعات) -I_2 (رى كل ٤ أيام وساعات تشغيل ٤ ساعات) -I_3(رى كل ٤ أيام وساعات تشغيل ٣ ساعات)-I_4 (رى كل ٤ ايام وساعات تشغيل ٢ساعات) وهذه المعاملة تمثل ظروف الإجهاد المائي مع أشجار الخوخ

أهم النتائج يمكن تلخيصها فيما يلى :

- أعلى متوسطات القيم بالنسبة للماء المضاف والاستهلاك المائى لكل ريه وكذلك الموسمية /الفدان سجلت تحت معاملة الرى I_1 مقارنة ببباقى معاملات الرى I_4 I_2,I_3, و القيم ٦,٥٤سم /فدان /ريه (٢٧٤,٦٨..م٣/فدان /ريه)' ٧٨,٤٨سم/فدان /موسم (٣٢٩٦.١٦م٣/فدان /موسم)للماء المضاف .بينما الاستهلاك المائى القيم هى ٥,٦٤ سم /فدان / ريه (٢٣٦,٨٩ م^3 /فدان /ريه) ' ٦٧,٦٩سم/فدان /موسم (٢٨٤٢,٦٧ م^3 / فدان /موسم) .بينما أقل متوسطات القيم للمقاييس سالفة الذكر سجلت تحت معاملة الري I_4والقيم هى ٢.٦٩سم/فدان /رية (١١٣.٠٢م٣/فدان /رية) ، ٣٢.٢٩ سم/فدان /موسم (١٣٥٦.٢٧م^3 / فدان / موسم). فى حين القيم بالنسبة للأستهلاك المائى كانت ٢.١٤سم/فدان /رية (٨٩.٥٨م٣/فدان /رية) ' ٢٥.٦ سم/فدان /موسم (١٠٧٤.٩٣م٣/فدان /موسم) . بصفة عامة متوسطات القيم بالنسبة للماء المضاف والأستهلاك المائى يمكن ترتيبها تنازليا I_1, I_2, I_3 , I_4 .

- بالنسبة لتأثير معاملات الرى على كفاءة الاستهلاك المائى (Euc%) اعلى المتوسطات سجلت تحت معاملة الرى I_1 والقيمة ٨٦.٢٥% والاقل تحت المعاملة I_4 وكانت ٧٩.٢٧% . بالنسبة لانتاجية وحدة المياة المستهلكة والمضافة ،اعلى القيم سجلت تحت معاملة الرى I_4 والقيم ٤.٩٨كجم/م٣ ،٣.٩٥كجم/م٣ لانتاجية وحدة المياه المستهلكة والمضافة على الترتيب فى حين اقل القيم سجلت تحت معاملة الرى I_1 وكانت ٢.٠١كجم/ م٣ و١.٧٤كجم /م٣ لانتاجية وحدة المياه المستهلكة والمضافة على الترتيب

- بالنسبة للمحصول .ونسبة العقد والكلورفيل الكلى ومساحة الورقه ومحتوى الماء بالورقه والماء الحر والمرتبط ونقص الماء وكذلك تركيز النيتروجين والفوسفور والبوتاسيوم والماغنسيوم فى الاوراق تأثرت بشكل معنوى بمعاملات الرى فى كلا موسمى النمو ما عدا عدد الثمار المتساقطة قبل الحصاد فى الموسم الاول أوضحت عدم المعنوية لمعاملات الرى عليها . بصفة عامة اعلى القيم لكل المقاييس سالفة الذكر سجلت تحت معاملة الرى I_2 خلال موسمى الدراسة ماعدا المحتوى الكلى للماء حيث سجلت تحت المعاملة I_1 ' بينما اعلى القيم للماء المرتبط ونقص الماء والثمار المتساقطة قبل الحصاد سجلت تحت المعاملة I_4 فى خلال موسمى الدراسة