Effect of Water Regime on Yield, Fruit Quality and Some Water Relations of Peach under Conditions of Heavy Clay Soils

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ABSTRACT

The present trial was performed 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 impact of irrigation water regime on yield, fruit quality and some water relations of peach trees under heavy clay soils condition. The investigation was carried out on "Early Grand" Peach tress eight years old budded on Nemaguard rootstock and spaced at 5×5 metre apart. The studied soil is heavy clay in texture. The used experimental design in this present is randomized completely block with four 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 (standard irrigation practice by local farmers as the control), I_2 (giving 12 irrigations through the vegetative growth period), I_3 (giving 9 irrigations through the vegetative growth period) and I_4 (giving 6 irrigations through the vegetative growth period, which represents water stress conditions on peach plants trees).

The data revealed that the highest overall mean values for water applied (Wa) consumptive use (Cu) and consumptive use efficiency (Ecu) were recorded under irrigation treatment I1 and the values are 101.82 cm (4276.52) m^3/fed.), 66.99 cm. (2813.44$m^{3/}$fed.) and 65.79% for Wa, Cu and Ecu, respectively. Meanwhile, the lowest values were recorded under irrigation treatment I_4 and the values are 76.25 cm. (3202.55 m^3/fed.) 47.61 cm. (1999.66 m^3/fed.). And 62.47% for Wa, Cu and Ecu, respectively. Concerning, water productivity (WP) and productivity of irrigation water (PIW), the highest overall mean values were recorded under irrigation treatment I_2 and the values are 2.70 kg/$m^3$and 1.73 kg/m^3 for WP and PIW, respectively. On the other hand, the lowest values were recorded under irrigation treatment I_1 (standard) and the values are 2.16 kg/$m^3$and 1.43 kg/m^3 for WP and PIW, respectively.

Regarding, yield and fruit quality of peach" Early Grand" were significantly affected by irrigation treatments, where, water stress conditions significantly decreased yield and fruit quality except pre-harvest fruit drop (%), V.C Juice, fruit firmness, fruit acidity and TSS /acid ratio which increased under stressful conditions (I_4), in comparison with other yield and fruit quality parameters were significantly increased under non-stressful treatments, where the highest mean values were recorded under the conditions of irrigation treatment I_2.

Key words: water regime, peach, water relations, heavy clay soils.

INTRODUCTION

Peach tree is one of the most important and successful deciduous fruits grown in Egypt. The total planted area has increased rapidly through the last decades. It reached about 78580.46 faddans in which produced 273256 tons/years (FAO, 2010).Extension of the cultivated area is due to its highly economic value, exporting potential and introducing new low chilling cultivars. Early Grand is an early cultivar that matures at second week of May under Egyptian conditions. It exhibited a high adaptation to arid agriculture.

Agriculture is the main sector in water demand at the national level. Water allocation in irrigation is about 85% from the total national available water. Hence, effective water management at the irrigation sector is the principal way towards the rationalization policy of the country. In this aspect, effective irrigation management on-farm level becomes a must. One of the main procedures to achieve this target is through how much water should be applied by studying water regime of peach trees through investigation of the suitable number of irrigations required for best yield and fruit quality. The irrigation custom creates different problem for both soil and cultivated trees caused by soil water logging, raising soil water table and pathological disorders. The research on peach irrigation has been reviewed by several authors (Berman and Dejony, 1996 and Naor *et al.*, 2001)

In Egypt, although, the needed quantity of irrigation water is available the ideal use of this water is essential. This minimizing water use not only reduce production cost but also help to meet the environmental regulation due to reduce the leaching of nutrients into ground water (Hanks, 1983). Soil moisture content is one of the main factors that most likely affect water in plant tissues. Under optimum level of soil moisture content, water distribution in plant tissues occurs at level very suitable for growth, development and fruiting (Mills *et al.*, 1996and Mpelasoka *et al.*, 2001). Moreover, fruit size is a major criterion of peach fruit quality. Since fruit thinning and irrigation are considered the two agricultural practices that affected fruit size (Berman and Dejony, 1996 and Naor *et al.*, 2001).

Aforementioned, the main objective of this present investigation was to study the effect of irrigation treatments (number of irrigation during vegetative growth period and amount of water applied) on yield fruit quality and some water relations of "Early Grand " peach trees budded on Nemaguard rootstock grown in heavy clay soils.

MATERIALS AND METHODS

A field trial was performed 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 impact of irrigation water regime on yield, fruit quality and some water relations of peach trees under heavy clay soil conditions. The investigation was carried out on eight years old "Early Grand " peach trees budded on Nemaguard rootstock spaced at 5×5 metre apart. The studied soil is heavy clay in texture. The selected trees were in a proper health condition and uniform in both vegetative growth and fruit load. The used experimental design in this present study is randomized completely block 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= Traditional irrigation like to practice by local farmers in the studied area, giving 15 irrigation through the vegetative growth period

I2= giving 12 irrigation through the vegetative growth period

I3= giving 9 irrigations through the vegetative growth period

I4= giving 6 irrigations through the vegetative growth period

All agricultural practices were carried out according to the crop and the area except the studied treatments which above mentioned before. Some physical, soil constants and chemical properties of the studied site were shown in Tables (1&2), respectively. The meterological data of the studied period were presented in table (3).

Some physical properties, soil water constants and chemical properties:

The studied physical properties and soil water constants such as mechanical analysis were determined according to the international pipette method. Soil bulk density, soil field capacity and permanent wilting point were determined according to (Klute, 1986). Available soil moisture was calculated as the difference between the field capacity and permanent wilting point. The studied chemical properties, such as soil reaction (PH) values were determined in 1:2.5 soil water suspensions (Jackson, 1973). Total soluble salts were measured by using electrical conductivity (EC) apparatus in the saturated soil paste extract (Jackson, 1973). Soluble cations and anions (Ca^{++}, Mg^{++} , Na^+, K^+, CO_3^-, HCO_3^-, Cl^- and SO_4^{--}as (meq/L) were determined in soil paste extract (Jackson, 1973), but SO_4^{--} was calculated by the difference between soluble cations and anions.

Table 1: Some physical properties soil water constants for the studied soil at different depths (average of the two growing seasons).

Soil depth, cm	Particle size distribution (%)			Texture class	F.C. (%)	P.W.P(%)	AW (%)	bd Mg/m^3
	sand	silt	clay					
0-15	26.0	28.0	46.0	clayey	47.0	25.3	21.7	1.19
15-30	29.0	23.0	48.0	Clayey	39.0	21.8	17.2	1.16
30-45	26.5	26.0	47.5	Clayey	38.0	21.9	16.1	1.30
45-60	27.5	25.5	47.0	Clayey	38.5	20.8	17.7	1.20
Mean	27.3	25.6	47.1	Clayey	40.	22.5	18.2	1.21

Where:

F.C=soil field capacity (%) P.W.P=permanent wilting point (%)

AW=available water (%) bd=soil bulk density (Mg/m)

Table 2: Some chemical properties for the studied soil at different depths (average of the two growing seasons).

Soil depth, cm	Ec, dsm^{-2}	PH	Soluble cations meq/L				Soluble anions meq/L			
			Ca^{++}	Mg^{++}	Na^+	K^+	CO_3^-	HCO_3^-	Cl^-	SO_4^{--}
0-15	1.50	8.15	0.30	0.10	0.76	0.02	-	0.55	0.21	0.42
15-30	1.57	8.00	0.31	0.10	0.79	0.02	-	0.57	0.22	0.43
30-45	1.65	8.00	0.34	0.10	0.89	0.02	-	0.65	0.23	0.47
45-60	2.78	7.90	0.84	0.27	1.25	0.03	-	0.45	0.23	1.71
Mean	1.63		0.45	0.14	0.92	0.02	-	0.56	0.22	0.76

Note: SO_4^{--} was determined by the difference between soluble cations and anions

Table 3: Mean of some meterological data for KafrEl-Sheikh area during the two years

Month	T (C°)			RH%			W_S	Pan Evap.	Rain mm
	Max	Min	Mean	Max	Min	mean	m/sec	Mm/day	
					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).

Data collection

Some water relations

1- Water applied (Wa.m$^{3/}$ fed)

Water applied was computed as described by (Girippa, 1983).

Wa =IW+Re

Where:

Wa = amount of water applied (cm& m$^{3/}$ fed)

IW = Irrigation water delivered and

Re = Effective rainfall, which means that, incident rainfall *0.7(Novica, 1979).

Irrigation water delivered:

Submerged flow orifice with fixed dimension was used in conveyand measure the irrigation water applied, as the following equation (Michael, 1978).

$$Q = CA\sqrt{2gh}$$

Where:

Q = Discharge through orifice, (cm^3 sec^{-1})

C = coefficient of discharge (0.61).

A = Cross sectional area of arifice, cm^2

g = Acceleration due to gravity, cm/sec^2

h = Pressure head, over the orifice center cm.

Total number of irrigation was events 15, 12, 9 and 6 for treatments I_1, I_2, I_3 and I_4, respectively.

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

To compute the actual consumed water of the growing plants, soil moisture percentage was determined (0n 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).

$$CU = SMD = \sum_{i=1}^{i=4} \frac{\theta_2 - \theta_1}{100} x Dbi x Di$$

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),

Di = soil layer thickness (15cm.),

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

Q_1 = soil moisture percentage before the next irrigation and

Q_2 = soil moisture percentage 48 hours after irrigation.

3- Consumptive use efficiency (Ecu, %)

Value of water consumptive use efficiency (Ecu, %) was calculated according to **(Bos 1980).**

Ecu = (Etc/Wa)×100

Where

Ecu = consumptive use efficiency (%)

Etc = total évapotranspirtion – consumptive use and

Wa = water applied to the field.

4- Water productivity (WP, kg/m³).

Water productivity is generally defined as crop yield per cubic meter of water consumption .Water productivity is defined as crop production per unit amount of water used (Molden, 1997). Concept of water productivity in agricultural 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 fruits /m³)

Y=fruit yield (kg/fed.) and

ET= total water consumption – consumptive use (m³/fed.)

5- Productivity of irrigation water (PIW, kg/m³)

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

PIW=Y/Wa

Where:

PIW = Productivity of irrigation water (kg fruits /m³)

Y = fruit yield (kg/fed.) and

Wa = Water applied to the field (m³).

These treatments were arranged in a completely randomized block design with three replicates for each treatment and every replicate was represented by a single tree. Four limbs at the four directions of each tree were selected and labeled in February. The following parameters were determined:

1-Fruit set and fruit drop percentages:

The total number of flowers on each limb was counted at full bloom. 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 fruit were recorded till commercial harvesting time, then estimated as a percentage on the basis of initial number of set fruitlets according to this equation :

No. of dropped fruitlets

Pre-harvest fruit drop percentage =

$$\frac{\text{No. of dropped fruitlets}}{\text{Initial No.of set fruitlets}} \times 100$$

2- Yield per tree:

Fruits were harvested at maturity stage (1st week of May), from each tree of various replicates and the numbers of fruits per tree were counted for each treatment. Tree yield in kilograms was estimated by multiplying number of fruit per tree and average fruit weight for each treatment.

3- Fruit quality:

Fruit sample consisting of ten fruits were randomly taken at harvest time from each replicate for the determination of both physical and chemical characteristics.

3.1 Physical characteristics:

Fruit weight (g), fruit size (ml), fruit dimension (fruit height and diameter in, mm), fruit shape index (fruit height /fruit diameter ratio) and fruit firmness (I b/inch²) which was measured by fruit pressure tester on the two opposite sides of the fruit.

3.2. Fruit chemical characteristics:

Total soluble solids (TSS) were determined using a hand refracto-metre, percentage of titratable acidity in fruit juice (%) was determined according to A.O.A.C., (1995), total soluble solid/ total acidity ratio were calculated vitamin C content (expressed as mg V.C/100 ml juice) were determined as outlined by A.O.AC.(1995) and anthocynins were quantified according to (Fuleki and Francis, 1968)

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 LSD test at 0.05 level was used for comparing between averages.

RESULTS AND DISCUSSION.

A. Irrigation parameters:.

1- Seasonal amount of water applied (Wa,cm&m³/fed.):

Present-ed data in Table (4) clearly illustrated that the seasons values of amount of water applied were affected by irrigation treatments (number of irrigation during the vegetative growth period) in the two growing seasons. The highest values were recorded under irrigation treatment I1 (Standard irrigation) and the values were 100.74 cm.(4231.34 m³/fed.) and 102.90 cm.(4321.70 m³/fed.) in the first and second growing seasons, respectively. Meanwhile, the lowest values were recorded under irrigation treatment I4 (Water stress conditions) and the values are 74.32cm (3121.37 m³/fed.) and 78.18cm (3283.73 m³/fed.) in the first and second growing seasons, respectively.

Table 4: Effect of irrigation treatments on amount of seasonal water applied for peach trees in the growing seasons

Irrigation treatments	1st growing season		2nd growing season		The overall mean values through the two growing seasons	
(I)	Cm	m^3/fed.	cm.	m^3/fed.	cm.	m^3/fed.
I1	100.74	4231.34	102.90	4321.70	101.82	4276.52
I2	85.61	3595.78	87.51	3675.30	86.56	3635.54
I3	80.73	3390.83	82.16	3450.77	81.45	3420.80
I4	74.32	3121.37	78.18	3283.73	76.25	3202.55

Note: The amount of water applied included the amount of Rain fall during the growing seasons.
I1=Giving 15 irrigation through the growing season (control).
I2= Giving 12 irrigation through the growing season,
I3= Giving 9 irrigation through the growing season, and
I4= Giving 6 irrigation through the growing season.

Generally, the seasonal amount of water applied for peach trees "Early Grand" can be descended in order $I_1>I_2>I_3>I_4$, this means that (15, 12, 9 and 6 irrigations through the vegetative growth period, respectively). Increasing seasonal amount of water applied under traditional irrigation (I1) comparing with other irrigation treatments I_2, I_3 and I_4 may be due to increasing number of irrigations under these condition, and hence, decreasing irrigation intervals therefore, increasing amount of water applied. These results are in a great harmony with those obtained by (Treedy *et al.*, 2007) on Navel orange, (Cogo *et al.*, 2011) on Broccoli, (El-Abd *et al.*, 2012) on Navel orange and (Garcio and Brunton 2013) on peach.

2-Water consumptive use (Cu, cm& m^3/fed.)

Data in Table (5) indicated that the values of water consumptive use of peach trees "Early grand " were greatly affected by irrigation treatments in the two growing seasons .The highest seasonal values for water consumptive use were recorded under irrigation treatment I_1 (Traditional irrigation) and the values were 66.44 cm.(2790.47 m^3/fed.) and 67.53 cm. (2836.40 m^3/fed.) in the first and second growing seasons, respectively .Meanwhile, the lowest seasonal values were recorded under irrigation treatment I_4 (water stress conditions) and the values were 47.26 cm.(1985.00 m^3/fed) and 47.96cm(2014.31 m^3/fed.) in the first and second growing seasons, respectively. The seasonal values for water consumptive use can be descended in order I1>I2>I3>I4 in the two growing seasons. Increasing the seasonal values of water consumptive use under irrigation treatment I1 comparing with other irrigation treatments I2, I3 and I4 may be attributed to increasing the amount of water applied and hence, increasing availability of soil nutrients. Consequently, increasing uptake rate of these nutrients and so forming strong and healthy trees with a thick vegetative cover, therefore, the canopy area which exposes to sunlight increases .Consequently, the rate of transpiration through vegetative cover increases. Transpiration considers one the main components of water consumptive use. So, under the conditions of irrigation treatment I1 the seasonal values of water consumptive use increases. These results are in a great agreement with those reported by Perez-Sarmiento *et al.*, 2010) on Apricot and (Bordonaba and Terry (2010) on straw berry, (El-Abd *et al.*, 2012) on" Navel orange trees " and (Garcio and Brunton 2013) on peach.

3-Consumptive use efficiency (Ecu, %), water productivity (WP.kg/m^3) and productivity of irrigation water (PIW, .kg/m^3)

Presented data in Table (6) clearly showed that, the values of consumptive use efficiency, water productivity and productivity of irrigation water were greatly affected by irrigation treatments (number of irrigations). Concerning, the values of Ecu, the highest values were recorded under irrigation treatment I1 (Traditional irrigation) and the values are 65.95 and 65.63% but the lowest values were recorded under irrigation treatmentI4 (water stress conditions) and the values were 63.59 and 61.34% in the first and second growing seasons, respectively. Generally, the values of Ecu can be descended in order I1>I2>I3>I4 in the two growing seasons. Increasing the values of Ecu under irrigation treatment I1 (Traditional irrigation) may be due to increasing the amount of water consumptive use and water applied under the conditions of traditional irrigation comparing with I2, I3 and I4 and hence, increasing the values of Ecu.

Regarding water productivity (WP) and productivity of irrigation water (PIW) the values of the two studied and above mentioned parameters were affected by irrigation treatments. The highest values were recorded under irrigation treatmentsI2 and the values were 2.74 and 2.65 (kg/m^3) for WP and 1.76 and 1.69, (kg/m^3) for PIW in the first and second growing seasons, respectively. Meanwhile, the lowest values were recorded under irrigation treatmentI1 (Traditional irrigation) and the values were 2.21 and 2.11 (kg/m^3) for WP and 1.46 and 1.39(kg/m^3) for PIW in the first and second growing seasons, respectively.

Table 5: Effect of irrigation treatments on amount of water consumptive use for peach trees in the two growing seasons:

Irrigation treatments (I)	1st growing season		2nd growing season		The overall mean values through the two growing seasons	
	cm.	m^3/fed.	cm.	m^3/fed.	cm.	m^3/fed.
I1	66.44	2790.47	67.53	2836.40	66.99	2813.44
I2	54.92	2306.83	55.79	2343.03	55.36	2324.93
I3	51.24	2152.16	52.07	2186.81	51.66	2169.49
I4	47.26	1985.00	47.96	2014.31	47.61	1999.66

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 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
I1	65.95	2.21	1.46	65.63	2.11	1.39	65.79	2.16	1.43
I2	64.15	2.74	1.76	63.75	2.65	1.69	63.95	2.70	1.73
I3	63.47	2.59	1.64	63.37	2.61	1.66	63.42	2.60	1.65
I4	63.59	2.55	1.62	61.34	2.63	1.61	62.47	2.59	1.62

Generally, the values of WP and PIW can be descended in order $I_2>I_3>I_4>I_1$, this means that, under water stress conditions the values of WP and PIW increased comparing with traditional irrigation which recorded the lowest values. Increasing the values of WP and PIW under water stress comparing with non-stressed treatments especially traditional irrigation may be attributed to decreasing the amount of water consumptive use and water applied under stressed conditions and hence increasing the values of WP and PIW. Also, recording the highest values for WP and PIW under irrigation treatment I2 comparing with other irrigation treatments I1, I3 and I4 may be due to recording the highest mean values for fruit yield under the conditions of this treatment.

These results were in a great harmony with those reported by Fathi (1999) on "le conte" pear, Abdel-Messeih and EL-Gendy (2004 b) on "cannio" apricot, Mikhael and Mady (2007) on "Anna "apple and Ibrahim and Abd El-Samad (2009) on "Mnafalouty" Pomegmanate. They indicated that agradual decrease in water use efficiency (WUE) or which so-called water productivity (WP) values due to increase the amount of water applied. Also, these results were 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 use efficiency or which so-called productivity of irrigation water (PIW) 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 findings were found by (El- Abd *et al.*, 2012) on Navel orange trees "and (Garcio and Brunton 2013) on peach trees.

B- Yield and fruit quality (physical and chemical fruit properties):

Presented data in Tables (7 to 10) clearly showed that both yield and fruit quality were significantly affected by irrigation treatments except yield (kg /tree and kg/fed.), fruit number in the first growing season only and TSS /acid ratio in the two growing seasons not significantly affected by irrigation treatments.

Table 7: Effect of irrigation treatments on yield (kg/tree), yield (kg/fed.) fruit set (%) and pre-harvest fruit drop (%) for peach in the two growing seasons.

Irrigation treatments (I)	1st growing season				2nd growing season			
	Yield (kg/tree)	Yield (kg/fed.)	Fruit set (%)	Pre-harvest fruit drop(%)	Yield (kg/tree)	Yield (kg/fed.)	Fruit set (%)	Pre-harvest fruit drop (%)
I1	36.67	6160.56	84.1	19.17	35.67	5992.56	82.3	18.57
I2	37.67	6328.56	85.5	17.60	37.00	6216.00	84.1	17.37
I3	33.17	5572.56	82.3	19.97	34.00	5712.00	81.9	20.47
I4	30.17	5068.56	80.3	22.20	31.50	5292.00	78.8	22.30
F.test LSD at 5%	NS	NS	** 0.7320	** 0.7533	** 1.099	**	** 0.9131	** 0.8318

Table 8: Effect of irrigation treatments on fruit weight (g), fruit number/tree, fruit size (cm^3.) and fruit diameter (cm.) for peach in the two growing seasons.

Irrigation Treatments (I)	1st growing season				2nd growing season			
	Fruit weight (kg)	Fruit number /tree	Fruit size (cm^3.)	fruit diameter (cm.)	Fruit weight (kg)	Fruit number /tree	Fruit size (cm^3.)	fruit diameter (cm.)
I1	95.67	405.33	75.33	5.73	94.67	376.67	73.33	5.63
I2	98.67	413.67	76.00	5.77	96.33	384.00	74.67	5.67
I3	93.33	398.33	70.67	5.50	91.33	372.67	70.33	5.20
I4	91.33	371.00	69.00	5.27	88.67	355.33	68.00	5.13
F.test LSD at 5%	* 3.3257	NS	** 1.8108	** 0.1131	** 2.3926	* 13.5593	* 2.4386	** 0.1131

Data in the same Tables also illustrated that the values of fruit yield, fruit set, fruit weight, fruit number/ tree, fruit size, fruit diameter fruit length and fruit shape were significantly increased by increasing irrigation numbers (amount of water applied), where the highest mean values for the abovementioned properties were recorded under irrigation treatment I2(giving 12 irrigations through the vegetative growth period) compared with other irrigation treatments I1, I3 and I4(giving 15, 9 and 6 irrigations through the vegetative growth period), respectively. Meanwhile pre-harvest fruit drop fruit firmness, fruit TSS, fruit acidity and TSS/acid ratio were significantly reduced by increasing amount of water applied (number of irrigation) in the two growing seasons.

The reduction in fruit weight and size under deficit soil moisture content could be due to reduced cell enlargement and to decrease cell water content (Li *et al.*, 1989). Furthermore, (Behbudian *et al.*, 1994) pointed out that, reduced fruit size under water stress conditions might be due to less assimilate availability through the reduction of net photosynthesis rate.These results coincided with those reported by (Chalmers *et al.*, 1985), (Genard and Huguet 1995) on peach, (Atkinson *et al.*, 2000), (Mikhael and Mady 2007) on apple and Mikhael *et al.*, (2010) on peach they mentioned that, fruit weight and size were markedly increased by irrigation. Also, these results were in line with those obtained by (EL-Abd *et al.*, 2012) on Navel orange and (Garcio and Brunton 2013) on peach

Table 9: Effect of irrigation treatments on fruit length (cm), fruit shape (L/D), fruit firmness (Ib/In) and fruit TSS (%) for peach in the two growing seasons.

Irrigation Treatments (I)	1st growing season				2nd growing season			
	fruit length (cm.)	fruit shape (L/D)	fruit firmness (Ib/In)	fruit TSS (%)	fruit length (cm.)	fruit shape (L/D)	fruit firmness (Ib/In)	fruit TSS (%)
I1	6.10	1.05	12.40	8.67	5.67	1.01	12.50	9.00
I2	6.27	1.09	13.17	8.67	5.87	1.08	12.97	9.47
I3	5.60	1.06	13.20	9.60	5.60	1.03	13.03	10.33
I4	5.57	1.02	13.70	10.03	5.37	1.05	13.67	11.17
F.test LSD at 5%	** 0.1178	* 0.0297	* 0.5584	* 0.7657	** 0.1155	** 0.0141	** 0.2759	** 0.4237

Table 10: Effect of irrigation treatment on fruit acidity (%), TSS /acid ratio, Anthocyanin (mg/g fresh) and V.C (mg/100 ml Jucie) for peach in the two growing seasons

Irrigation Treatments (I)	1st growing season				2nd growing season			
	fruit acidity (%)	TSS /acid ratio	Antho cyanin (mg/g fresh)	VC(mg/100 ml Jucie)	fruit acidity (%)	TSS /acid ratio	Antho cyanin (mg/g fresh)	VC(mg/100 ml Jucie)
I1	0.82	10.589	0.208	8.50	0.98	9.18	0.191	7.90
I2	0.90	9.63	0.205	9.13	1.04	9.11	0.197	8.85
I3	0.89	10.79	0.193	9.25	1.12	9.22	0.2000	8.60
I4	0.93	10.79	0.195	9.53	1.12	9.97	0.190	8.57
F.test LSD at 5%	** 0.0303	NS	** 0.0004	** 0.0648	** 0.0261	NS	* 0.0004	** 0.0551

CONCLUSION

Under limitation of water resources in Egypt which focused on the River Nile that supplies Egypt with about 97% from fresh water, and the importance of peach crop on the national level as an export crop. Thus, it is considered a source for hard currency to the country. Rationalized of irrigation water for this crop becomes a must to maximize productivity of irrigation water unit. Therefore, this investigation recommends that "Early Grand "peach growers in the studied area under heavy clay soil conditions, should irrigate this type of peach 12 irrigation instead of 15 irrigation through the vegetative growth period to obtain the highest yield and most fruit quality parameters, which saves a large amount of irrigation water on the national level and creates the highest values for water productivity and productivity of irrigation water ,In other words, maximizing productivity of both consumed and applied water units.

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الملخص العربى

تاثير المقنن المائى على المحصول وجودة ثمار الخوخ وبعض العلاقات المائية تحت ظروف الأراضى الطينية الثقيلة

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أجريت هذه الدراسةخلال موسمى نمو ٢٠١٣ و٢٠١٤ وذلك فى مزرعة خاصة بمركز سيدى سالم –محافظة كفر الشيخ بهدف دراسة تأثير النظام المائى على محصول الخوخ وجودة الثمار وبعض العلاقات المائية تحت ظروف الأراضى الطينية الثقيلة – التجربة نفذت على اشجار الخوخ صنف (Early Grand) وكان عمر الأشجار٨ سنوات ومسافات الزراعة ٥*٥ م.الأشجار التى تم اختيارها كانت ذات نمو ثمرى وخضرى جيد- التصميم الأحصائى المستخدم فى الدراسة قطاعات كاملة العشوائية فى أربع مكررات.عشرون شجرة تم إختيارها وقسمت الى اربع مجموعات كل مجموعة نفذت عليها واحدة من المعاملات الأتية I1 (رى عادى، وكما يمارس المزارع العادى، ١٥ رية خلال فترة النمو الخضرى)، I2 (اعطاء ١٢ رية خلال فترة النمو الخضرى، I3(اعطاء ٩ ريات خلال فترة النمو الخضرى)، I4 (اعطاء ٦ ريات خلال فترة النمو الخضرى) وهذه المعاملة تمثل ظروف الأجهاد المائى مع أشجار الخوخ

أهم النتائج يمكن تلخيصها كما يلى:

- أعلى متوسطات القيم بالنسبة للماء المضاف وألاستهلاك المائى وكفاءة الإستهلاك المائى سجلت تحت معاملة الرى I1 والقيم هى ١٠١,٨٢سم (٤٢٧٦,٥٢م³/فدان) و٦٦,٩٩سم (٢٨١٣,٤٤ م³/فدان) و٦٥,٧٩% وذلك بالنسبة للماء المضاف والاستهلاك المائى وكفاءة الاستهلاك المائى على الترتيب اقل القيم سجلت تحت معاملة الرى I4 والقيم هى ٧٦,٢٥سم (٣٢٠٢,٥٥ م³/فدان)، ٤٧,٦١ سم (١٩٩٩,٦٦ م³/فدان) و٦٢,٤٧% للماء المضاف والاستهلاك المائى وكفاءة الاستهلاك المائى على الترتيب. بالنسبة لانتاجية وحدة المياه المستهلكة والمضافة سجلت مع القيم تحت معاملة الرىI 2 والقيم ٢٧٠كجم/م³ و١٧٣ كجم/م³ مع الترتيب ولكن اقل القيم سجلت تحت معاملة الرى I1 (رى عادى) والقيم ٢١٦ كجم/م³ و١٤٣ كجم/م³ للانتاجية وحدة المياه المستهلكة والمضافة على الترتيب
- بالنسبة للمحصول وجودة الثمار لصنف الخوخ (Early Grand) تاثرت بشكل معنوى ماعدا النسبة المئوية للثمار المتساقطة قبل الحصاد، فتيامتينC، صلابة الثمار، حموضة الثمرة وكذلك نسبة TSS/acid والتى زادت تحت ظروف الإجهاد المائى I4 بالمقارنة بمقاييس المحصول والجودة الأخرى التى زادت بشكل معنوى تحت المعاملات الأخرى التى لم تتعرض لأجهاد مائى حيث سجلت اعلى المتوسطات تحت ظروف معاملة الرى I2.