Scheduling Trickle Irrigation Using Soil Matric Potential for"Le Conte" Pear Trees Planted in Calcareous Soils

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ABSTRACT

The present research was carried out in 2007 and 2008 years on 6 years old of "Le Conte" pear trees grafted on communis rootstock and grown in calcareous soil at Burg El-Arab region, Alexandria Governorate. The objective of this work was to investigate the effect of three irrigation rates based on soil matric potential measurements, which was as: (T1): high irrigation rate (-300 to -500 mbars), (T2): medium irrigation rate (-500 to -820 mbars) and (T3): low irrigation rate (-820 to -1762 mbars), on: vegetative growth, leaf chemical content, yield, fruit quality and water use efficiency (WUE).

The main results of this work can be summarized in the following points:

- **Trees grown under (T1) (from 100 to 80% of A.W), were significantly produced high shoot length, shoot diameter, leaf area fruit yield, high fruit quality (F. length, diameter & weight) and gave higher water use efficiency (WUE). Also, these trees gave the highest leaf mineral composition (N, P, K, Ca, Mg, Fe, Mn & Zn) and leaf total chlorophyll followed by (T2) (from 80 to 60% of A. W) & (T3) (from 60 to 40% of A.W) for the two seasons.**
- **On the other hand, trees grown under (T3) produced significantly high leaf free proline with fruits of highest firmness, acidity%, TSS% and total sugars% followed by those grown under (T2) and (T1) respectively, in the two studied seasons.**
- **Based on the above general results, the irrigation treatment (T1) is recommended for the irrigation of "Le Conte" pear trees planted in calcareous soil at Burg El- Arabe region (Egypt) using the trickle irrigation system scheduled via the soil matric potential measurement using tensiometers.**

Keywords: Scheduling Irrigation, Trickle irrigation system, Soil matric potential, pear trees, leaf mineral composition, water use efficiency.

INTRODUCTION

Of all the materials used by fruit trees for growth and pears as well, water is taken up in the largest amount. The evaporated water in a well- watered tree is replaced by absorption from the soil. if absorption is insufficient to replace evapotranspiration losses, the water status of the tree is changed, its "water potential" is lowered, and many of its life processes are affected, like influencing cell division and expansion; flower bud differentiation; and decreasing carbohydrate production through altering stomatalaperture and enzyme activities of photosynthesis and respiration. On the other side, waterlogging around plant roots create undesirable conditions, causing a negative effects on root activities.

In Egypt, both of water and food are in short supply, farmers already have to learn how to use water in the most efficient way possible to get maximum production from each unit of water and land. Several methods have been used to estimate plant requirement. The comparative merits of these methods for estimating evapotranspiration of fruit trees have been reviewed by (Elfving, 1982). It is critical to satisfy the water requirement to fruit trees at the beginning of the growing season when fruit set occurs, during the period of flower bud formation, and when the final fruit swell occurs before harvest. It has been known for a long time that drought lowers productivity in fruit trees, what is now beginning to be understood is that water use is directed related to productivity even under conditions when the trees are not visibly stressed from drought. Dry- weight increases in apple (Gyuro, 1974) and peach (Richards, 1976; Richards and Rowe, 1976) are proportional to the amount of water transpired. The fact water use, directly and proportionally, affects yield makes water relations a central issue in fruit production and fruit tree physiology. If soil and plant water potentials are used to indicate irrigation needs, however, the irrigator does not know anything about the amounts of water in the soil i. e., the percent of available moisture, or the amounts used by the plants. Instead of detailed information about amounts of water. The matric potential methods utilized only two easily acquired units of information. One is the matric potential in the field at defined depth. These data are as simple and easy to obtain as reading on the dial of a manometer or moisture block meter. The other involves knowing what these readings would be when the crop is irrigated (Taylor, 1965). Records of matric potentials taken at frequent time intervals provide a means of evaluating and prescribing when and how much water should be applied without reference to soil moisture content.

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The main objective of the present investigation was to study the influence of soil matric potential treatments on the vegetative growth , leaf chemical composition, yield and fruit quality of " Le Conte" pear trees under calcareous soil condition beside, saving irrigation water via irrigation scheduling, using drip irrigation system.

MATERIAL AND METHODS

This work was carried out at Burg El- Arab region , Alexandria Governorate, during two successive seasons, (2006- 2007) and (2007 – 2008) on 6 years old of "Le Conte" pear trees (Pyrus communis. L.× Pyrus pyrifolia. N.) on communis rootstock planted on a calcareous soil. Some soil properties of the experimental site are shown in Table (1). The treated trees were spaced at 5X6 meters apart. The trees were selected to be healthy and similar in their vigor, as possible, and treated with normal agricultural practices. There were two lateral lines of drip irrigation system for each row of the trees on the two opposite sides. Four emitters per tree (8L/h) installed on the lateral line in a location opposite to tree trunk at 50-cm from tree trunk. 50-cm distance was between the two emitters and one meter between lateral lines. Thirty six trees were chosen for the present investigation.

To calculate the quantity of applied water for irrigating the pear trees , a soil moisture retention curve (SMRC) as shown in Fig (1) was determined for the whole soil profile till 150 cm depth using pressure plate apparatus in laboratory according to (Black, 1965).

SMRC's model was obtained for this curve using van Genuchten (1980). This model was used to obtain the soil moisture content at 330, 500, 820 and 1762 mbar to calculate quantities of applied water for irrigating the three treatments of soil matric suction (Table 2). van Genuchten model (1980) is as the following:

$$\theta_h = \theta_r + (\theta_s - \theta_r) [1+ (\alpha h)^n]^{-m}$$

Where:

$\theta_{h,}$ is the volumetric soil moisture content at h,mbar.

$\theta_{r,}$ is the volumetric residual soil moisture content.

θ_s, is saturation point on volume fraction.

α, is the inverse of the air entry suction (h_b), and

n &m, are constants of the fitting curve.

Soil matric potential (h) could be obtained via rewrite the model in h as function to θ as shown in model 1 El Gendy 2006:

$$h = -h_b \left[\left(\frac{\theta - \theta_r}{\theta_s - \theta_r} \right)^{-\left(\frac{1}{m}\right)} - 1 \right]^{\frac{1}{n}}$$

Where:

h_b , is air entry suction ($1/\alpha$)

The soil bulk density (BD) was determined for 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105, 105-120, 120-135, and 135-150 cm depths using a soil cylinder (5-cm in diameter and 10 cm in height) according to Black (1965).

Irrigation Treatments:

Irrigation treatments (Table:2) were calculated from SMRC and its model (fig.1) according to van Genuchten (1980). The same treatments were used in the two years of study.

Mercury Tensiometers were used to control irrigation process in the first two treatments but the third treatment was controlled by detecting volumetric water content to reach at 13.98 % (equals to 1762 mbar) using model 1 El Gendy (2006) because tensiometer is not valid over 850 mbar. Tensiometers were installed at 55 cm depth beside the emitter in each treatment.

The experimental treatments were arranged in a complete randomized block design and the treatment was replicated in 6 times in each replicates, i.e. 3 treatments X 6 replicates X 2 experimental unit= 36 trees.

Table 1. Some soil physical and chemical properties of the experimental site

Physical Properties					
Soil property	Soil layer, cm		Average	Other properties	
	0- 60	60-150			
Sand	63.00%	46.00%	54.50%	FC(at 330 mbar)	22.91%
Silt	32.60%	31.22%	31.91%	WP (at 15000 mbar)	8.04%
Clay	4.40%	22.78%	13.59%	AW	14.87%
Soil texture	Loamy			AVE.BD, g/cm^3 from 0 to 150 cm depth	1.4313
Chemical properties					
pH	8.17	8.21	8.19		
EC, dS/m	2.56	2.12	2.34		
$CaCO_3$ %	31.55	34..33	32.94		

O.M%	0.65	0.43	0.54

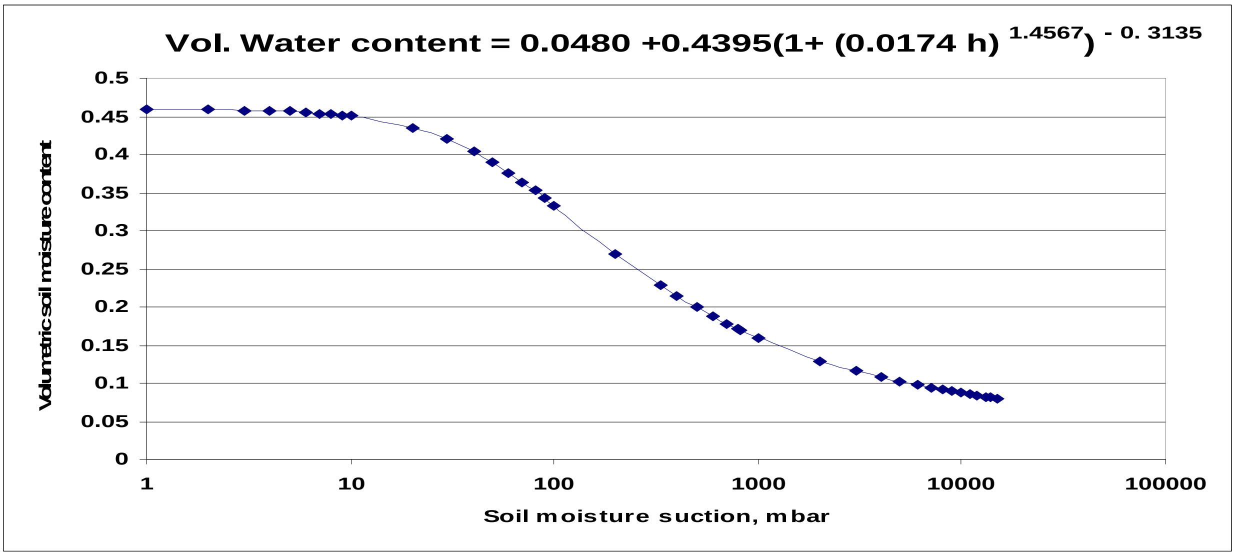

Fig. 1. Soil moisture retention curve of the soil under study

Table 2. Irrigation treatments, which were used in this study

Treatments	Soil matric potential, and ratio from A.W	Volumetric soil moisture content (θ v) at irrigation time	Water quantity / tree/ irrigation, liter
(T1): high irrigation	Ranged from (-330 to -500 mbar)as well as from 100 to 80% AW	At -500 mbar and At 80% AW θ v = 19.94%	70
(T2): Medium irrigation	Ranged from (-500 to -820 mbar) as well as from 80 to 60%AW	At -820 mbar and At 60%AW θ v = 16.96%	70
(T3): Low irrigation	Ranged from (-820 to - 1762 mbar) as well as from 60 to 40%AW	At - 1762 mbar and At 40% AW θ v = 13.98%	70

Vegetative Growth measurements

Four main branches as uniform as possible were chosen at the four cardinal points of each experimental tree. Tagged and the average of the current shoot number per selected branch was counted, their length and diameters were measured on the first of November. To determine the leaf area , samples of 10 mature leaves were collected at random from each studied tree on mid September, washed with tap water and dried with a piece of cotton tissue. The determination of leaf area was carried out using leaf area meter (Model CL-203, CID, Inc, USA).

Determination of leaf chemical contents:

1-Total chlorophyll :

Leaf total chlorophyll content was determined by using Minolta chlorophyll meter SPAD- 502 (Minolta camera Co. LTD JAPAN). Ten readings were taken on ten leaves (the fourth leaf of the new shoot) of each experimental tree on mid July. The reading was taken at the middle of leaf blade (Abd El- Messeih, 2000).

2-Free proline :

Leaf samples were taken on the mid of August in 2007 and 2008 years and free proline content was determined according to Singh et al. (1973) by using 0.5 gm of dried mature leaf sample which was homogenized in 10 ml 3.5% sulpho-salicyllic acid and centrifuged for 5 minutes at 300 rpm and decanted, then filtered throw whatman No. 2 filter paper. The supernatant was diluted and injected in Beckman Amino Acid Analyzer 119 CL. The proline concentration was determined from standard curve and calculated on dry weight basis.

3-Mineral composition:

Twenty mature leaves were collected at random, at mid of June in the two studied seasons. The leaves were washed several times with tap water, rinsed three times in distilled water, and then dried at 70-80 ^oC in an electric air – drying oven.

The dried leaves of each sample were ground, 0.3 gm from the ground dried material of each sample was digested with $H_2 O_2$ and $H_2 SO_4$ according to Evenhuis and Dewaard (1980). Suitable aliquots were then taken for minerals determination. Total nitrogen and phosphorus were determined colorimetrically according to Evenhuis (1976), and Murphy and Riley (1962), respectively. Potassium was determined against a standard, using air propane flame photometer (Chapman and Pratt, 1961).Calcium and magnesium were measured, using versinate method (Chang and Bray, 1951) and iron, manganese and zinc by a Perkin- Elmer atomic absorption spectrophotometer Model 305-B. the concentrations of nitrogen, phosphorus, potassium, magnesium and calcium were expressed as percent, while those of iron, manganese and zinc were expressed as parts per million (ppm) on dry weight basis.

Yield and Fruit Quality:

The total yield of each studied tree was determined on weight basis, in Kgs at the harvest time in the mid of August of both seasons. 20 mature fruit from each studied tree were taken at random to determine fruit quality, in each sample, fruit weight was recorded as (gm), fruit dimensions(length and diameter in cm), firmness was determined according to Magness and Teytor (1925) pressure tester using a 5/16$^{=}$ plunger. Total soluble solids (TSS) in the juice were determined using a hand refract meter and the acidity percentage was determined according to AOAC(1980). Total sugars content was determined according to Malik and Singh (1980). Water use efficiency (WUE) was calculated according to Viets (1962) and Begg and Turner (1976) as follows:

WUE = [(Yield, Kg/tree. year)/(Applied water, m^3 /tree. year)], Kg/m^3

Statistical Analysis:

The obtained data throughout the two studied growing seasons were statistically analyzed according to Sendecor and Cochran (1990) and L.S.D test at 0.05 level was used for comparison between treatments..

RESULTS AND DISCUSSION

Vegetative Growth:

Data in Table (3) cleared that high irrigation (T1) significantly induced high shoot number, shoot length, shoot diameter and leaf area followed by medium irrigation (T2) and low irrigation (T3), in the two studied seasons. In spite of, using a huge amounts of irrigation water in T(1) than in T(2) in the two years of study, the shoot number of pear trees were not statistically significant. The drastic influence on vegetative growth attributes induced by low irrigation (T3) in both studied seasons. These data are supported by those of Chalmers et al. (1986) who reported that withholding irrigation (WI) followed by regulated deficit irrigation (RDI) reduced vegetative growth of pears by 52%. Besides, El- Morshedy et al. (1997) mentioned that decreasing amount of irrigation water amount significantly decreased shoot growth and leaf area of "Le Conte" pear trees growing at El- Nubaria area, Bohira Governorate. In addition, Hipps (1997) reported that the consistently irrigation increased new shoots of apples compared with no irrigation. Moreover, Abd El- Messeih and El- Gendy (2004)a noted that using high irrigation rate induced significantly high TCA increase, shoot length, shoot diameter, promoted shoot number per main branches and supported leaves to increase in their area of Canino apricot trees than normal, medium and deficit irrigation, respectively.

Leaf mineral composition:

Data listed in Table (4 &5) indicated that in both studied seasons increasing amount of irrigation water amount significantly increased leaf macro elements (N, P, K, Ca and Mg) and micro elements (Fe, Mn, and Zn). The influence of all studied treatments could be arranged as the following descending: T(1)>T(2)>T(3). Many investigators supported these data. Brun et al. (1985) mentioned that pear leaf analysis revealed little effect of irrigation practice on the concentrations of N, P, Ca and Mg. In addition, trees protected from rainfall by tent-like covers of polyethylene has less foliar N, P and K based on either concentration or amount per unit leaf area than unprotected trees, Erf and Proctor (1989). Buwalda and Lenz (1992) reported that water stress reduced the N, P and K contents of apple trees cultivars." Golden Delicious, Cox's Orange Pippin and Gloster". Further more, El- Morshedy et al. (1997) noticed that the high rate of application water coincided with high leaf K percentage of "Le Conte" pear trees. Moreover, Abd El-Messeih and El- Gendy (2004)b reported that decreasing irrigation water amount decreased leaf N, P, K, Ca, Mg, Fe, Mn and Zn of Canino apricot trees planted in sandy soil.

Leaf Total Chlorophyll Content:

Table (5) cleared that low leaf total chlorophyll was found in trees grown under low irrigation treatment (T3) while, high leaf total chlorophyll was obtained from trees grown under high irrigation treatment (T1) followed by those grown under medium irrigation treatment (T2) in both studied seasons. Moreover, the differences among the different irrigation treatments were significant. This reaveled that decreasing the amount of irrigation water caused a significant decrease in leaf total chlorophyll which in turn, could be an indirect effect of decreasing leaf N and Mg as consequence of low irrigation. N and Mg elements are necessary for chlorophyll synthesis, Bidwell(1979) and Mengal and Kirkby (1982). Yakushiji et al. (1998) cleared that the net photosynthetic rate of leaves of Satsuma mandarin trees under moderately drought stressed and severely drought – stressed was reduced to about 1/3 and 1/5 of that of well watered ones, respectively. In addition, Abd El- Messeih (2000) stated that the leaf total chlorophyll content of "Anna " apple trees significantly increased with increasing irrigation rate during three experimental seasons. the same trend was found by Abd El- Messeih and El- Gendy (2004)b on Canino apricot trees.

Leaf Free Proline Content:

Data in Table (5) indicated that leaf free proline content of "Le Conte" trees grown under low irrigation treatment (T3) was significantly high followed by (T2) and (T1), in both studied seasons. In other meaning, there was a negative correlation between the irrigation rate and leaf free proline content. This indicate that deficit irrigation stimulates the biosynthesis and accumulation of this amino acid in leaves and in the same time caused a significant reduce in leaf total chlorophyll than moderate and high irrigation. In addition, the accumulation of leaf free proline content in trees under water stress(deficit irrigation) may be due to that trees could not be able to synthesize more chlorophyll and protein.

These data are in general agreement with many previous researches, Stewart (1972) mentioned that water stress is associated with wilting which induces an increase of non-protein proline formation in bean leaves. Same trend was indicated by Hussein (1998) on apples. Also, under sever water stress (100% depletion)seedlings synthesized about ten folds of proline values as compared with those grown under favorable water condition, Draz (1986) on bitter almond and Abd El- Motelb(1991)on grapevine. In addition, decreasing irrigation water level significantly increased leaf free- proline, Abd El- Messeih (2000) on "Anna" apples and Abd El- Messeih and El- Gendy(2004) b on "Canino " apricot trees.

Yield and Fruit Quality:

Data in Table (6) cleared that as irrigation water amount applied per tree decreased fruit yield/tree decreased. The highest fruit yield was obtained from tree grown under (T1) high irrigation (42.38 and 46.33 Kg/tree) followed by those of trees grown under (T2) medium irrigation (36.27 and 39.76 Kg/tree) and those of trees grown under (T3) low irrigation (28.01 and 31.16 Kg/ tree) in 2007and 2008, respectively. The differences between all studied treatments were statistically significant. In addition, the reduction in fruit yield was 14.4% and 14.20% for (T2) and was 33.9% and 32.7% for (T3) than trees grown under (T1) in the first and second season, respectively. Many researches supported these data, Hipps (1997) reported that the total yield of Lobo apples from irrigated trees was 22.3% higher than this from no irrigated ones. In addition, Prazak (1992); Velickovic and Jovanovic (1993) and Holzapfel et al. (1995) reported that increasing irrigation water rate increased yield of apples.

Data in Table (6) indicated that length, diameter and weight of fruit significantly increased with increasing applied irrigation water rate while, fruit firmness was decreased in both studied years. All differences between treatments were statistically significant except fruit firmness between (T1) and (T2) only. As for chemical properties (fruit acidity%, TSS% and total sugars%) it was found a negative correlation between applied irrigation water rate and this parameters (Table 7). In other meaning, fruit of trees grown under (T3) have high acidity%, TSS% and total sugars% followed by medium irrigation (T2) and (T1) high irrigation, respectively. These data agreed with many investigators. Yakushiji et al. (1996) mentioned that when Satsuma mandarin trees were grown under mulch cultivation, the total sugar contents of fruit were significantly higher than in well- watered fruit at harvest. In addition, Yakushiji et al. (1998) reported that fruits of Satsuma mandarin trees under severely drought stressed have significantly high (acidity %) and (SSC%) followed by these of trees under moderately drought and under well watered ones, respectively. Also, they found that (the total pulp sugar content “g”) was significantly high in fruit of trees under moderately drought (stressed) than of trees under well watered. Moreover, El Morshedy et al. (1997) stated that decreasing irrigation water to 75% of the control increased Juice TSS % and sugars content of fruits of “ Le Conte” pear trees.

Water Use Efficiency (WUE) :

Data in Table (7) indicated that trees planted under high irrigation (T1) induced significantly high water use efficiency (WUE) followed by (T2) and (T3), respectively in both studied seasons(the differences between (T1) & (T2) in 2007 were not statistically. In other meaning, (WUE) was increased parallel to increasing the amount of irrigation water. Thus trees grown under (T1) induced good vegetative growth, high fruit yield of good fruit quality beside high WUE than (T2) and (T3) in both studied seasons. It is considered more economic if the outcome and income was taken in consideration. These data agreed with that of Storchus & Kosykh (1983) on peach, Abd El- Messeih (2000) on apples and Abd El- Messeih & El – Gendy (2004) bon Apricots.

Irrigation Scheduling:

Data in Table (8) indicated that under (T1) tree received 12880 and 12915 liters in 2007 and 2008, respectively. Tree under (T2) received 10920 & 12390 liters, while tree under (T3) received 8960 & 10430 liters in 2007 and 2008, respectively. In addition under all tested treatments trees used the lowest water quantity on January, increased gradually till August then decreased gradually again till November in the two studied years. This scheduling is considered fixed because of using manometers, which determine when we must irrigate trees depending on soil matric potential measurements. Tables (7, 8 and 9) and Figs. (1 and 2) cleared the behavior of used irrigation water by “le Conte” pear trees in this study.

Plant and Water relationship:

Table (8) and Figs. (2, 3 & 4) illustrate the relationship between months and the depleted applied water under the three treatments among both seasons 2007 &2008 of "Le Conte" pear trees. The depleted water increases gradually with month sequences from January to July to reach the maximum at mid July, after that it decreases gradually till November . This trend was found for the three water treatments (T1, T2, and T3). These figures illustrated also, that the water depletion rate was as follows :: T(1) > T(2) > T(3)

It is worthy to mention that the depleted water calculated from tree area around the tree, which was (125X150=18750 cm^2= 1.875 m^2) and from soil volume around the tree equal to (125 X 150 X 150 =2812500cm^3 =2.8125 m^3). The same trend was used for the two seasons (2007 &2008)

Table 3. Effect of irrigation treatments on the vegetative growth of "Le Conte"pear trees during 2007and 2008

Irrigation treatments	SMP#, mbar		Shoot Number		Shoot length, cm		Shoot diameter, cm		Leaf area, cm^2	
	from	to	2007	2008	2007	2008	2007	2008	2007	2008
High Irrigation (T1)	-330	-500	14.6	15.8	88.7	92.4	1.2	1.4	31.42	33.52
Medium irrigation (T2)	-500	-820	13.8	14.9	73.6	77.8	0.9	1.1	28.26	29.77
Low irrigation (T3) severe stress	-820	-1762	13.7	14.5	59.8	65.6	0.7	0.8	24.18	25.21
LSD at 0.05	------	------	0.9272	1.3286	1.0386	1.7323	0.0739	0.0661	1.6229	2.0157

Soil matric potential

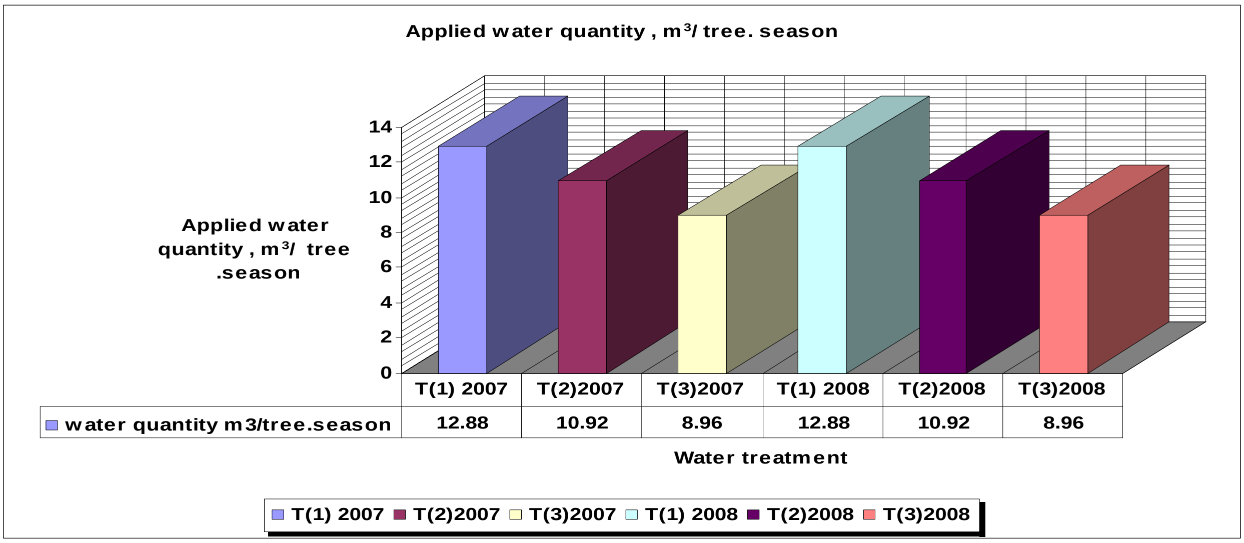

Fig. 2. Applied water quantity for "Le Conte" pear trees under the three treatments (T1, T2, and T3) during the two grown seasons (2007 &2008)

Table 4. Effect of irrigation treatments on the leaf macro elements content (on dry weight basis) of "Le Conte" pear trees during 2007 and 2008

Irrigation treatments	SMP, mbar		N%		P%		K%		Ca%		Mg%	
	from	to	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
High Irrigation (T1)	-330	-500	2.21	2.31	0.22	0.23	1.24	1.28	1.33	1.37	0.31	0.33
Medium irrigation (T2)	-500	-820	1.92	1.95	0.17	0.18	1.18	1.19	1.26	1.28	0.25	0.26
Low irrigation (T3) severe stress	-820	-1762	1.68	1.65	0.14	0.13	1.13	1.11	1.21	1.19	0.21	0.20
LSD at 0.05	------	------	0.0412	0.0506	0.0262	0.0247	0.0302	0.0292	0.0364	0.0364	0.0321	0.0236

Table 5. Effect of irrigation treatments on the leaf micro elements content (on dry weight basis), leaf total chlorophyll and leaf free proline of "Le Conte" pear trees during 2007 and 2008

Irrigation treatments	SMP#, mbar		Fe, ppm		Mn, ppm		Zn, ppm		Leaf total chlorophyll , reading (SPAD)		Leaf free proline, mg/100gm dry weight	
Year	from	to	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
High Irrigation (T1)	-330	-500	107.22	108.36	55.01	56.21	42.16	44.21	39.77	40.16	4.83	4.84
Medium irrigation (T2)	-500	-820	103.29	103.55	52.21	55.17	38.18	39.17	35.65	36.68	6.15	6.33
Low irrigation (T3) severe stress	-820	-1762	97.86	96.21	50.15	48.14	33.15	31.16	31.24	31.44	7.86	8.17
LSD at 0.05	------	------	1.7359	1.9242	1.9123	2.9452	1.6699	1.6813	1.7197	2.5366	0.1163	0.0841

Table 6. Effect of irrigation treatments on the yield and fruit physical properties of "Le Conte" pear trees during 2007 and 2008

Irrigation treatments	SMP#, mbar		Yield/tree, Kg		Fruit length, cm		Fruit diameter, cm		Fruit weight, gm		F. Firmness, Ib/inch^2	
Year	**from**	**to**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**
High Irrigation (T1)	-330	-500	42.38	46.33	7.20	7.40	6.40	6.50	158.45	165.55	11.96	11.96
Medium irrigation (T2)	-500	-820	36.27	39.76	6.80	6.94	6.20	6.40	150.36	158.43	11.92	11.93
Low irrigation (T3) severe stress	-820	-1762	28.01	31.16	6.60	6.75	5.90	5.40	144.18	146.22	12.25	12.46
LSD at 0.05	------	------	1.4777	1.8804	0.0873	0.0273	0.0494	0.0473	3.8236	2.6867	0.0463	0.0651

Soil moisture potential

Table 7. Effect of irrigation treatments on fruit chemical properties and water use efficiency of "Le Conte" pear trees during 2007 and 2008

Irrigation treatments	SMP#, mbar		Fruit acidity %		Fruit TSS %		Total sugars %		Water use efficiency, Kg/m^3	
Year	**from**	**to**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**
High Irrigation (T1)	-330	-500	0.39	0.39	12.25	12.29	8.92	8.96	3.29	3.59
Medium irrigation (T2)	-500	-820	0.41	0.42	12.85	12.90	9.85	9.91	3.32	3.21
Low irrigation (T3) severe stress	-820	-1762	0.43	0.43	13.36	13.45	10.14	10.34	3.13	2.99
LSD at 0.05	------	------	0.0214	0.0194	0.0740	0.0371	0.0452	0.0549	0.1147	0.1217

Table 8. The quantity of irrigation water applied to each tree (liters) in the different irrigation treatments during 2007 and 2008

Season	Treatments	Months											Total
		Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	
2007	T1	210	630	770	1190	1470	1680	1820	1890	1470	1050	700	12880
	T2	140	560	630	1050	1330	1400	1540	1610	1330	840	490	10920
	T3	70	420	490	840	1120	1190	1260	1330	1120	700	420	8960
2008	T1	280	700	910	1330	1610	1750	2030	2170	1610	1260	840	12915
	T2	210	630	770	1120	1400	1540	1750	1820	1470	1050	630	12390
	T3	140	560	630	910	1190	1330	1470	1540	1330	840	490	10430

Table 9. The average of application rate of irrigation water per tree in the day (Liters/tree. day) in the different irrigation treatments during 2007 and 2008

Season	Treatments	Months										
		Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.
2007	T1	6.8	22.5	24.8	39.7	47.4	56.0	58.7	61.0	49.0	33.9	23.3
	T2	4.5	20.0	20.3	35.0	42.9	46.7	49.7	51.9	44.3	27.1	16.3
	T3	2.3	15.0	15.8	28.0	36.1	39.7	40.6	42.9	37.3	22.6	14.0
2008	T1	9.0	24.1	29.4	44.3	51.9	58.3	65.5	70.0	53.7	40.6	28.0
	T2	6.8	21.7	24.8	37.3	45.2	51.3	56.5	58.7	49.0	33.9	21.0
	T3	4.5	19.3	20.3	30.3	38.4	44.3	47.4	49.7	44.3	27.1	16.3

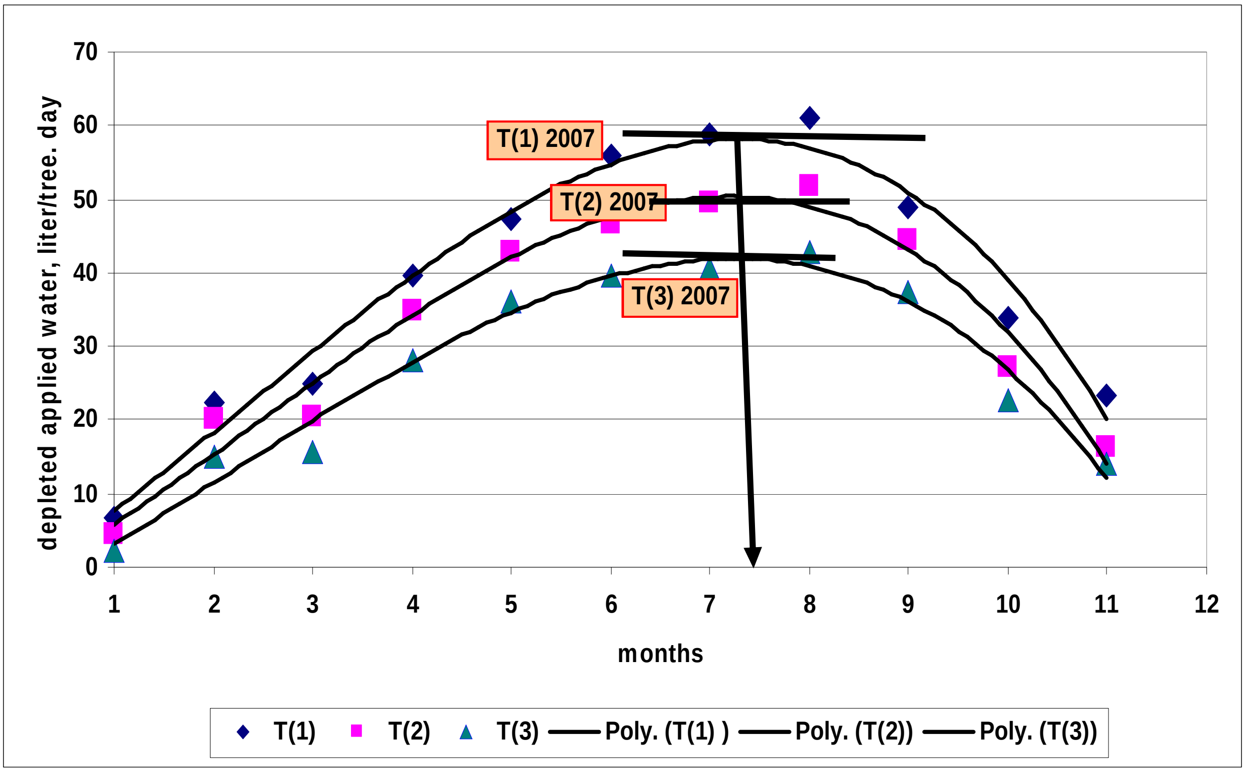

Fig. 3. The depleted irrigation water curves of "Le Conte" pear trees under the three studied treatments during 2007

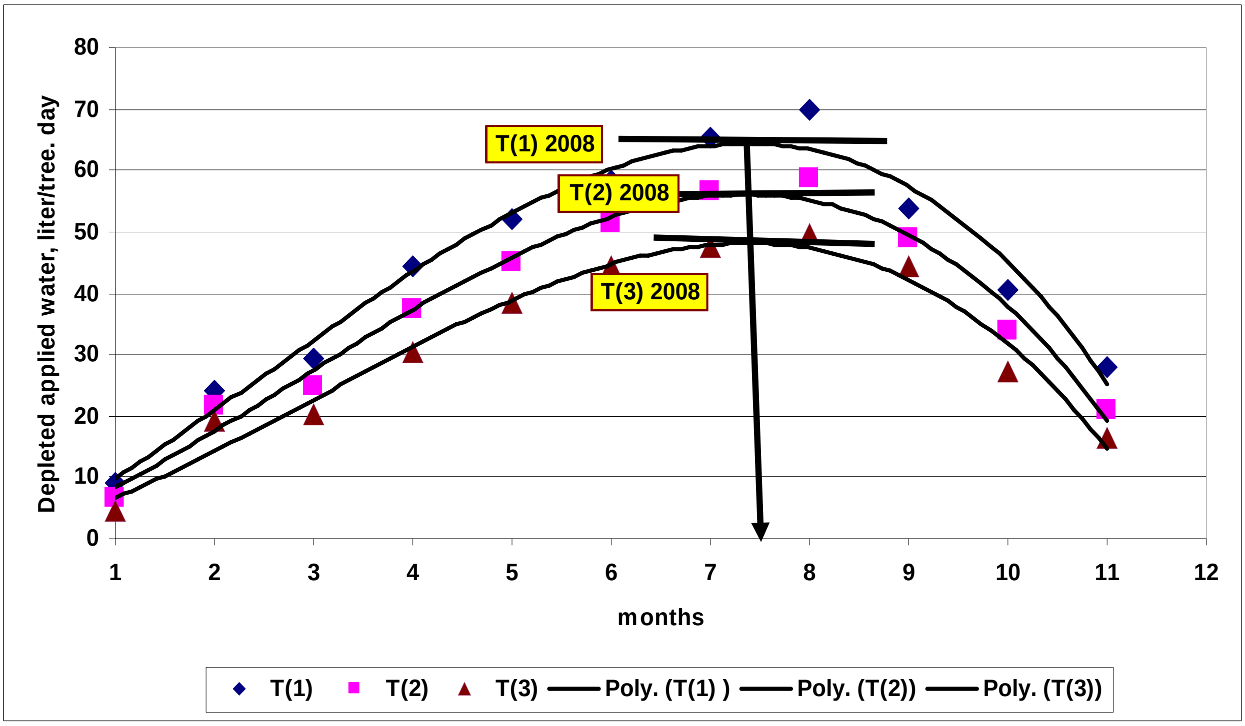

Fig. 4. The depleted irrigation water curves of "Le Conte" pear trees under the three studied treatments during 2008

Depleted water in the three water treatments represented in the following polynomial functions with high coefficient determination:

Y (T1 at 2007) = $-0.1464 X^3 + 1.0008 X^2 + 8.7276X - 1.947$, $R^2 = 0.9691$

Y (T2 at 2007) = $-0.1361 X^3 + 0.9437 X^2 + 7.6116X - 2.5864$, $R^2 = 0.9661$

Y (T3 at 2007) = $-0.1114 X^3 + 0.7275 X^2 + 6.9858X - 4.5258$, $R^2 = 0.9677$

Y (T1 at 2008) = $-0.1642 X^3 + 1.2471 X^2 + 8.4037X +0.3833$, $R^2 = 0.9688$

Y (T2 at 2008) = $-0.1612X^3 + 1.3549 X^2 + 6.2646X +0.8606$, $R^2 = 0.9786$

Y (T3 at 2008) = $-0.154 X^3 + 1.4098 X^2 + 4.3699X +1.0121$, $R^2 = 0.9678$

Where:

Y: is the depleted water, liter/tree. Day

X: is the number of the month of the growth season

According to the soil moisture stress within the treatments, applied water was in gradually decreasing from high at T(1) to Low at (T3) through the two growing seasons (2007 &2008) as shown in Fig. (2),

CONCLUSION

Using a huge amount of irrigation water has a drastic effect on both soil and trees grown in the soil beside using more costs. In order to use the correct amounts of irrigation water without causing damage for both of soil and trees or reduce vegetative growth and yield of good quality of trees, we must schedule irrigation via the soil matric potential near field capacity. This technique depending on soil matric potential measurements using tensiometers and has many advantages for " Le Conte" pear trees such as induced good vegetative growth, good yield of good fruit quality and high water use efficiency beside saving irrigation water.

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الملخص العربي

جدولة الري بالتنقيط باستخدام طريقة جهد الشد الرطوبي الأرضى لأشجار الكمثري"ليكونت" المنزرعة في الأراضي الجيرية

وصفي ماهر عبد المسيح، رشدي واصف الجندي

اجري هذا البحث في عامي ٢٠٠٧ و٢٠٠٨ علي أشجار الكمثري صنف "ليكونت" عمر ست سنوات والمطعومه علي أصل كميونس ونامية في أرض جيرية بمنطقة برج العرب محافظة الاسكندرية.

هدف هذا العمل هو بحث تأثير ثلاثة معدلات ري مبنية علي أساس قياسات الشد الرطوبي الأرضي. وهذه المعاملات هي: (T_1) معدل ري عالي: الري ما بين – ٣٣٠، - ٥٠٠ ملي بار، (T_2) معدل ري متوسط ما بين – ٥٠٠، ٨٢٠ ملي بار، (T_3) معدل ري منخفض : الري ما بين -٨٢٠، - ١٧٦٢ ملي بار علي النمو الخضري والمحتوي المعدني للاوراق والمحصول وصفات جودة الثمار وكفاءة استخدام المياه.

النتائج الرئيسية لهذا العمل يمكن تلخيصها في النقاط التالية: ـــ

- الأشجار النامية تحت (T1) (من١٠٠– ٨٠ % من الماء الميسر) أعطت معنويا أعلى طولا و قطرا للنموات الحديثة ومساحة للورقة ومحصول الثمار وصفات جودة (طول وقطر ووزن الثمرة) وكذلك أعطت أعلى كفاءة استخدام للمياه (WUE); أيضا هذه الاشجار أعطت أعلى محتوى معدني فى الأوراق (النتروجين، الفوسفور، البوتاسيوم، الكالسيوم، الماغنسيوم، الحديد، المنجنيز، الزنك) وأعلى كلوروفيل كلى فى الأوراق تلتها اشجار المعاملة (T2) (من ٨٠ – ٦٠% من الماء الميسر) ثم أشجار المعاملة (T3) (من ٦٠ – ٤٠% من الماء الميسر) على التوالى فى كلا من الموسمين.

- على الجانب الاخر فان الأشجار النامية تحت (T3) أعطت معنويا أعلى محتوى برولين الورقة الحر وكذلك ثمار عالية فى صلابتها ومحتواها من الحموضة% و المواد الصلبة الذائبة (TSS%) و من السكريات الصلبة % تلتها الأشجار النامية تحت (T2) و (T3) على التوالى فى موسمى الدراسة.

بناءا على النتائج السابقة فان معاملة الرى(T1) يوصى بها فى رى الكمثرى"ليكونت" المنزرعة فى الأراضى الجيرية فى منطقة برج العرب (مصر) باستخدام نظام الرى بالتنقيط المجدول على أساس قياس الشد الرطوبى الأرضى باستخدام التنشيومترات.