Misr J. Ag. Eng., 24(1): 103-121 IRRIGATION AND DRAINAGE

IRRGATION SYSTEMS EFFECT ON GROWTH AND PRODUCTIVITY IN MANGO ORCHARD

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ABSTRACT

The experiment was carried out at the farm of the Egyptian Tank Factory 200, El-Sharkya Governorate, from seedling mango in the first of March 2002 to harvest in August 2006. Mango cultivar Zebda was used to optimize irrigation in mango orchard by evaluating three different irrigation systems on vegetative growth and productivity. Data revealed that the tree height, stem girth and root length density increased more under using the sub-surface irrigation (SSI) than drip irrigation (DI) and furrow irrigation (FI). The average crop coefficients for the mango orchard productive cycle were (Kc = 0.69, 0.74 and 0.85)under SSI, DI and FI, respectively . The furrow irrigation causes the shot holes split disease, more than drip irrigation and sub-surface irrigation. It was 2.7, 2.1 and 0.6 % under using FI, DI and SSI, respectively. The average yield of mango under using SSI increased by 13.88% and 26.25% from DI and FI, respectively, because of the weed management, moisture distribution in root zone and irrigation efficiency with SSI best among other irrigation methods.

***Key words**: Mango-Irrigation systems - growth parameters- weed management- moisture distribution- crop coefficient.*

INTRODUCTION

Irrigation management for the mango crop must follow technical criteria, so that water is applied at the right time and the right amount . **(Phene,1991; Phene et al., 1992).** The studies by **Evanes et al. (1993), Oliveeira et al.(1993).Castel (1994),Sepaskhah and kashefipour (1995); Ferreira et al. (1996) and Michelakis et al. (1996)** are among few related to water requirements of fruit plantations. However, despite the great commercial and nutrition's value of its fruit, almost few field research has been done on mango orchards. Particularly so in relation to water consumption.

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Measurement of crop evapotranspiration becomes difficult when the plants have well developed root system such as the adult fruit trees. **Perdro et al. (2003)** observed that daily mango orchard evapotranspiration increased slowly from 3.1 mm per day at the beginning of the experimental period (middle July) to 4.9 mm per day at the maximum growth period of the fruit .Then it decreased to reach a 4.1 mm per day value, approximately at the full maturation fruit at a semi-arid region .The accumulated mango orchard water consumption for the whole productive cycle was 551.6 and 555.1mm. **Coelho and Borges (2004)** observed with subsurface drip irrigation that evaporation from the topsoil is reduced and water runoff is negligible.

Mango roots were evaluated under different irrigation systems. **Choudhury and Soares (1992)** studied root distribution in a sandy soil under drip irrigation with two irrigation lines per plant row, and observed that most of roots were found at distances of 0.3 m to 1.6 m from the plant at depths from 0.3 m to 0.9 m. **Soares and Cost (1995)** observed that 68% of the mango tree roots are of absorption and 86% of the supporting roots are located at a radius of 0.90-2.60 m soil surface from the plant trunk and in the soil layer from 0 to 1.2 m depth. They also observed that 65% of the absorption and 56% of the supporting roots are located in the soil depth down to 0.60 m.With surface drip irrigation ,roots grow preferentially around the emitter area **Oliveira et al.(1996)** which in turn can contribute to improve water availability to the plants when using subsurface drip irrigation.

Coelho et al.(2001) also studied a root system under drip irrigation with one irrigation line per plant row and five emitters per plant 0.5 m apart from each other. The larger concentration of roots (root density length) was observed at a distance from the plant less than 2.1 m and at depths from soil surface to 0.7 m.

The root distribution of mango crop has also been studied for different irrigation levels. **Oliveira (2001)** has evaluated root distribution for mango under irrigation to supply water depletion of 44% ETo and 137% ETo. Root system tended to expand with the increase of amount of irrigation applied. Nevrtheless, roots were more concentrated at the region limited by 1.75m from the plant, where 83% , 85% and 86% of total root lengths were found for treatments of ETo 44% , 86% and 137%, respectively .In these treatments. 72% to 76% of total length was at 0 to 0.8m depth. **El-Gindy et al. (2000)** found that low-head bubbler and gated pipe irrigation system produced better quality mango fruits rather than standard bubbler and gated pipe irrigation system. **Osman (2000)** showed that using gated pipe gave the highest mango yield by 37.2% . Also water was saved by 19.8% in mango compared with traditional system . Water utilization efficiency, by using improved surface irrigated mango and gated pipes, increased by 70.7% compared with traditional irrigation**. Agrawal et al., (2005)** studied the effects of trickle irrigation and surface method with and without plastic mulching on mango cv. Dashehari. Trickle irrigation with 0.6 volume of water + plastic mulch, gave the highest yield (29.80 t/ha), fruit width (5.82 cm) and length (8.89 cm), fruit weight (163.65 kg). Trickle irrigation with 0.4 volume of water + plastic mulch, gave the highest water use efficiency (0.052 t ha^{-1} mm^{-1})**. Osman, et al.(2005)** showed that the moisture content of soil in mango orchard under both traditional and gated pipes irrigation was higher than the bubbler irrigation system after 24 hours from irrigation time, while the moisture content of soil under bubbler irrigation system was higher than both gated pipe and traditional irrigation before the following irrigation. Also, the cover weed density in mango orchard decreased when compared with traditional irrigation method by 55.3%, 78.7%, and 61.7% under gated pipes, standard bubbler and low head bubbler system respectively.

The research objective is to optimize irrigation in mango orchard by evaluating different irrigation systems on vegetative growth, yield, the actual water requirements and moisture distribution. The goal is to maximize crop yield, quality of yield and overcoming environment problems.

MATERIALS AND METHODS

The research was carried out during period from 2002 to 2006 seasons at the farm of Egyptian Tank Plant Factory 200, El-Sharkya Governorate. Two mango cultivars Zebda and Kent of one year old seedlings were planted in the first of March 2002 in plastic pots (30 cm in diameter , well drained) filled with a mixture of peatmoss and quartz sand (1:4), one seedling per pot. Pits of one m^3 were dug at 5 x 5 m. The pits after weathering and filled with a mixture of 50-60 kg organic fertilizer ,2 kg of super phosphate, one kg of sulphur ,1 kg of the ammonium sulfates and 3 kg gypsum per pit added to the mixture before planting. The seedling plant had an average height of 82.5 cm , stem girth 3.1 cm. Analysis for the investigated soil was carried out according to **Wilde et al. (1985).** Results are shown in Table (1).

Table (1): Analysis of the investigated soil .

Particle size distribution:	
Coarse sand %	42.48
Fine sand %	48.3
Silt %	7.54
Clay %	1.68
Texture grade:	sandy loam
pH (1:2.5 extract)	8.3
E.C. (1 : 2.5 extract) (mmhos/cm)	0.87
$CaCO_3$ %	0.0
O.M. %	1.02
Available macronutrients :	
Total N %	0.02
P (Olsen, ppm)	1.21
K (ammonium acetate . ppm)	80.2
Mg++	7.50
SO_4 ++	0.54
DTPA extractable micronutrients	
(ppm) :	3.20
Fe	2.6
Mn	0.84
Cu	0.91
Zn	

Soil Analysis, Field capacity (8.7) and wilting point (3.8) were determined by the Soil Science Laboratory.

The experiment involved three different irrigation systems as follows:

a -Furrow irrigation (FI) :

Furrow irrigation (1.5 m wide, 20 cm raised beds were formed by bed shaper for each row of mango trees and 35 m length row was leveled at 0.1 % slope).Watering was done weekly from March to June and five days from June to August then weekly from August to December. The plant received a water stress for one irrigate during the month of January to March, before flowering.

b-Drip irrigation (DI) :

Single line drip system consisted of (18 mm diameter and 70 m length) with two drippers per plant. Average of dripper discharge at pressure 15 m was 4 Lh^{-1} located at a distance of 20-25 cm on each side of the plant till the trees were 3 years. After three years,two 8 Lh^{-1} drippers were placed per tree at a, distance of 40-50 cm on each side of the tree. The quantity of water was increased according to the age of the mango trees.

c -Sub-Surface irrigation (SSI) :

Sub-Surface irrigation (leaky pipes or porous pipes) were used. They are make of recycled rubber. The water exits out through the tine porous rubber wall under low pressure. Pipe external diameter was 14 mm, 2.2 mm wall thickness and the leak rate 6.8 L.m/h at pressure head 15 m. Double lines were used per each row of trees under depth 40 cm, with spacing 50 cm between lines along row (70 m length).

For economical cost, vegetables (cucumber, a pepper, onion, pea and etc.) were intercropped with mango trees under used furrow irrigation and sub-surface irrigation methods, took about 4 years for the mango canopy to close spacing between trees. Available water between trees under this methods was enough to produce multi crops to recover the initial investments made in raising the orchards.

1- Field measurements :

Field measurements were taken during the production cycle of a 5 years old mango orchard from March 2002 to February 2006.
The following measurements were taken :
- Plant height (cm)
- Stem girth (cm). Collected at 30 cm height from soil surface under all ages.

- Weed management (No. of weeds/ m^2). Weeding management in mango orchard was carried out by hand. Weeding by this method is labour intensive.

- Root length density RLD (cm/ cm^3). . RLD samples were collected from soil profile at layers (0, 25, 50, 75 and100 cm depth) with distance (0, 50, 75, 100, 150, 200 and 250 cm) from mango tree under all irrigation methods.

-Fruit yield (kg/fed.). At harvest, the total yield from each tree (kg/tree) was recorded after five tree years .Harvesting was carried out when the fruits were at the fully mature green stage.

2-Soil moisture distribution :

Soil moisture was monitored using the gravimetric method. Readings were taken after 6-8 hours from irrigation and right before the next irrigation. Soil samples were collected from four successive layers (0-25, 25-50, 50-75 and 75-100 cm) with distance (0, 50, 75, 100, 150, 200 and 250 cm) from mango tree under all irrigation methods.

3-Irrigation water requirements:

The mango orchard was irrigated with a water volume. V_w (liters per plant) according to Pedro et al. (2003).

$$V_w = \frac{E_{ca} \times K_t \times K_c \times A_p}{E_a}$$

where:

E_{ca} is the class-A pan evaporation, K_t = .85 is the pan coefficient , K_c is the crop coefficient, A_p (m^2) is the maximum soil surface area covered by a tree canopy and E_a is the irrigation efficiency

4 - The crop evapotranspiration ET_c.

The crop evapotranspiration ET_c mm was calculated from the soil water balance in the soil layer between surface and the maximum depth of mango tree roots , it was obtained as:

$$ETc = r + I \pm D_d (or C_r) \pm \Delta SM \pm R$$

Where:

r is the rainfall mm, I the irrigation mm, D_d (or C_r) the soil deep drainage or capillary rise, R the surface runoff and ΔSM the storage soil moisture change which was obtained by; $\Delta SM = SM_t - SM_{t-1}$ where SM_t and SM_{t-1} are the storage soil moisture at time instants t and t-1 ,respectively.

5-Reference evapotranspiration (ET_o) and crop coefficient (K_c) :

Daily reference evapotranspiration (ET_o) was obtained by Penman-Monteith equation as presented by **Allen et al. (1994)** as follows :

$$ET_o = \frac{0.408\Delta(R_n - G) + Y\frac{900}{T+273}U_2(e_s - e_a)}{\Delta + Y(1 + 0.34U_2)}$$

where:

R_n is net radiation at the crop surface (MJm^{-2} day^{-1}), G is soil heat flux density (MJm^{-2} day^{-1}), Δ the slope of vapor pressure curve (kPa $^oC^{-1}$) , U_2 (m s^{-1})is the average daily wind speed at 2 m above soil surface, T the mean daily air temperature at 2 m height (^oC), e_s saturation vapor pressure (kPa), e_a actual vapor pressure (kPa), (e_s- e_a) saturation vapor pressure deficit (kPa) and Y is the psych metric constant (kPa $^oC^{-1}$) . The crop coefficient was obtained as

$K_c = ET_c / ET_o$

6-Application water efficiency (Ea %)

Application efficiency, which representing the irrigation efficiency in this research as the irrigation water conveyed to field, was calculated according to **James (1988)** .

$$E_a = \frac{RZ}{dw} \times 100 \qquad RZ = \frac{D(\theta fc - \theta i)}{100}$$

where:

E_a is the efficiency of application (%), RZ is the amount of water stored in the root zone (mm), d_w the depth of water applied (mm) , D is the depth of effective root zone (mm), θfc and θi are the volumetric water contents in percent at field capacity and prior to irrigation ,respectively.

7-Water utilization efficiency WUE (kg/m^3) :

Water use efficiency (WUE) of a 5 years old mango trees, was estimated according to the following equation.

WUE = Y/ W (kg/m^3)

Where:

WUE is water use efficiency (kg/m^3), Y is the total of mango fruit yield, (kg/fed.) and W is total water applied, (m^3/fed.)

RESULTS AND DISCUSSION

1-Effect of different irrigation systems on growth of mango:

1-a-Trees vegetative growth parameter .

It is clear from the data in fig. (1) that sub-surface irrigation(SSI), improved both the stem girth and plant height of mango trees compared with drip irrigation (DI) and furrow irrigation (FI) methods. Results indicated that using SSI increased growth parameters for all age of trees more than DI and FI by 15.2 % and 21 % for plant height, 8.75 % and 19.6 % for stem girth, respectively .The increase in growing parameters with SSI was due to the available water in active root zone along time.

1-b-Root distribution:

Distribution of mango root length density (cm /cm^3) in the soil profile under different irrigation systems is shown in fig. (2). This figure shows that the irrigation method, water amount and soil water distribution are the main variables that affect root length density distribution. Most of the root length density was around the emitters zone in wetting circulars, concentrated within the depth 50 cm and distance 100 from tree. With the sub-surface irrigation, most of the roots growing along the irrigation pipe, was concentrated within 75 cm depth and distance 200 cm from tree, but without growth at the upper layers soil (0 - 10 cm) . Under furrow irrigation, root length density distribution tended more to deep soil than other irrigation methods.

2-Weed management :

The cover density of weeds (number of weed plants per square meter) which grow under and between mango trees with different irrigation methods through five years is shown in fig. (3).It shows that the growth of weed density decreased when SSI was used for mango trees. Weeds density at 5 years age under SSI decreased by 93.5 % and 84.9 % from FI and DI, respectively .The lowest weeds density was by using SSI its due to the moisture content at upper soil surface layer it is not enough to grown the weed plants .

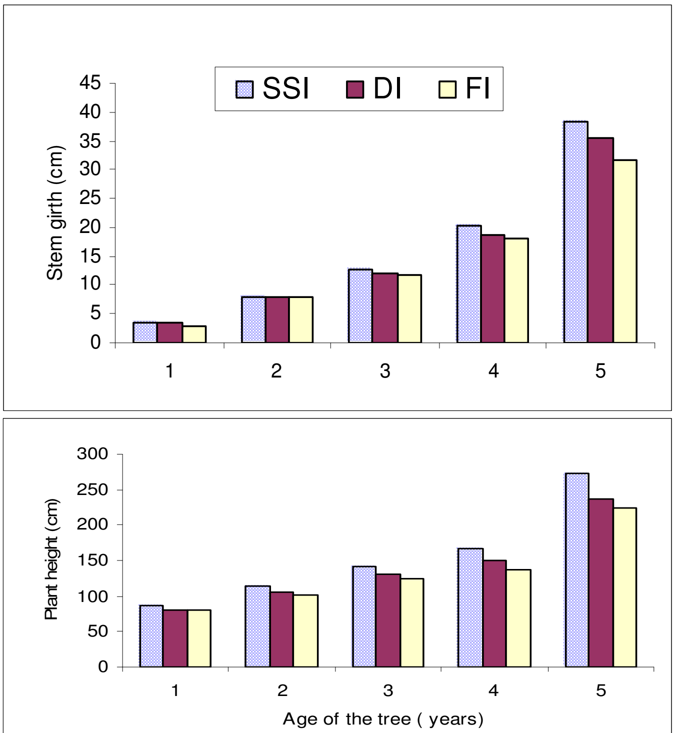

Fig. 1:Effect of irrigation methods on growth prameters of mango orchard.

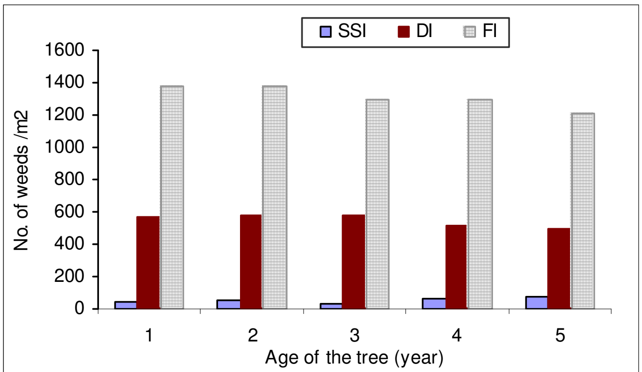

Fig.3 : Effect of irrigation methods on weed mangement in mango orchard.

3-Water application-rates:

The water application rates in mango orchard throughout the productive cycle for five years of trees age under different irrigation systems are presented in tables (2, 3 and 4) and fig. (4). The amount of water per tree increased by age of the tree under all irrigation systems. Also, the water amounts are not constant throughout its productive cycle. More water is needed in bagging stage (flowering). The maximum water amounts was at fruit develop stage. After that, water requirements rapidly decrease at fruit maturation stage to suit fruit quality.

Table 2: Water applied to mango trees orchard at various ages using sub-surface irrigation.

Month	Water applied (L. / day/tree)				
	Age of the tree (year)				
	1	2	3	4	5
March	68.62	62.66	63.43	68.88	70.57
April	74.66	70.45	68.78	71.53	74.25
May	82.33	78.35	80.44	82.33	85.68
June	90.11	92.23	94.96	96.88	100.47
July	94.66	96.44	96.97	98.65	104.58
August	92.63	90.60	88.53	80.81	90.63
September	84.34	80.42	81.67	72.65	76.18
October	80.55	82.33	78.78	70.36	72.85
November	70.41	67.66	70.46	70.11	70.12
December	68.36	60.83	62.89	65.45	66.32
January	50.24	50.4	52.44	8.46	6.32
February	54.81	50.34	46.87	6.89	6.41

Table 3 : Water applied to mango trees orchard at various ages using drip irrigation .

Month	Water applied (L. / day/tree)				
	Age of the tree(year)				
	1	2	3	4	5
March	32.86	45.41	54.54	66.84	70.81
April	40.16	50.22	61.22	70.55	78.69
May	44.44	54.23	64.71	81.31	85.54
June	54.65	62.44	70.47	91.36	102.62
July	66.34	57.28	80.68	92.68	108.29
August	60.11	70.91	81.66	85.22	88.22
September	56.32	66.21	72.44	83.41	85.60
October	45.36	60.02	70.26	72.65	78.68
November	42.86	51.12	62.53	70.32	72.47
December	36.21	46.43	54.13	62.24	70.12
January	26.44	36.25	30.05	16.33	8.28
February	26.14	36.56	28.95	16.82	9.02

Table 4 : Water applied to mango trees orchard at various ages using furrow irrigation.

Month	Water applied (L. / day/tree)				
	Age of the tree (year)				
	1	2	3	4	5
March	80.12	84.77	88.23	95.12	105.24
April	91.45	98.61	96.47	108.46	118.62
May	101.25	106.85	110.55	126.11	136.52
June	109.88	120.36	126.89	131.56	141.45
July	122.69	134.52	132.63	138.36	148.24
August	123.45	119.28	124.77	118.63	128.36
September	99.68	106.48	110.80	106.31	116.55
October	91.25	96.33	101.23	98.44	108.87
November	81.25	88.60	91.44	88.25	98.06
December	69.08	80.13	84.64	84.68	92.45
January	48.22	48.25	50.22	32.66	40.11
February	56.84	60.40	54.88	36.22	38.65

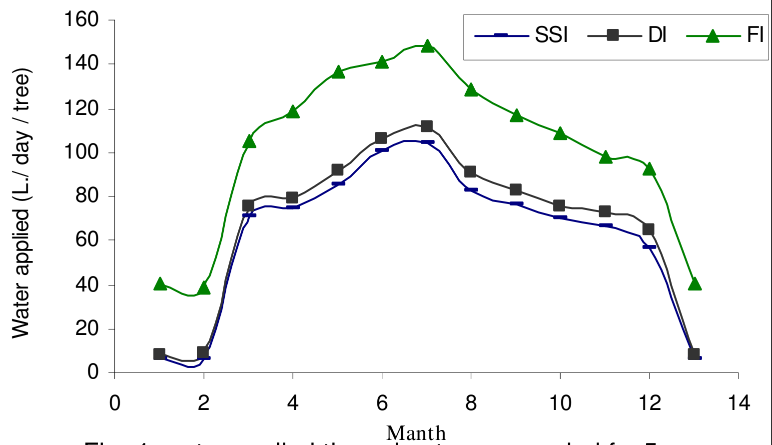

Fig. 4: water applied throughout a year period for 5 years old mango tree.

Fig. 5 shows the total applied water under different irrigation systems in mango orchard. This figure clarifies that the total applied water for all ages of trees under furrow irrigation system are more than that under DI and SSI. This is due to more surface runoff, evaporation and deep percolation. The water applied under DI during the early years of tree age (1-3 old trees) was lower than SSI, causes intercropping vegetables with SSI at early years uses more water for DI.

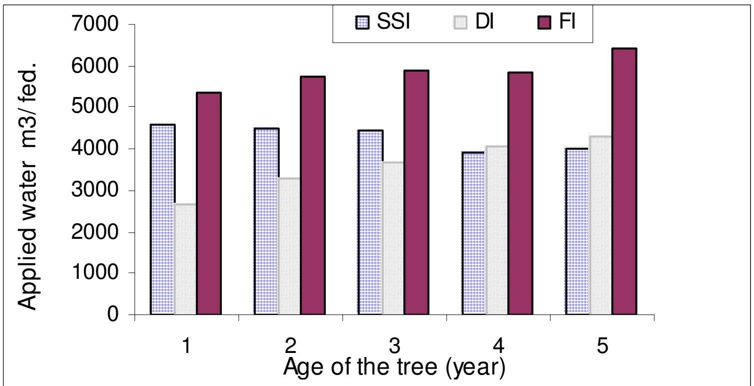

Fig. 5 :Water applied to mango trees under different irrigation sysetms.

4-Crop coefficient (Kc):

Values of the mango tree coefficient, are shown in fig. (6). This figure reveals that Kc changes throughout orchard productive cycle for 5 years old mango. It follows that water requirements are not constant. The average values of Kc at important stages of mango growth were:

{ flowering (1 March – 14 April), fruit fall (15 April – 25 May), fruit growth (26 may – 12 July) and fruit maturation (13 July – 15 August)} were 0.63, 0.77, 0.84 and 0.81, respectively, under using SSI, but under using DI, factors were 0.66, 0.79, 0.91 and 0.88. Also, with FI factors were 0.83, 0.94, 1.40 and 0.93 respectively. Generally, the average crop coefficient for mango tree productive cycle (Kc = 0.69, 0.74 and 0.85) using SSI, DI and FI respectively.

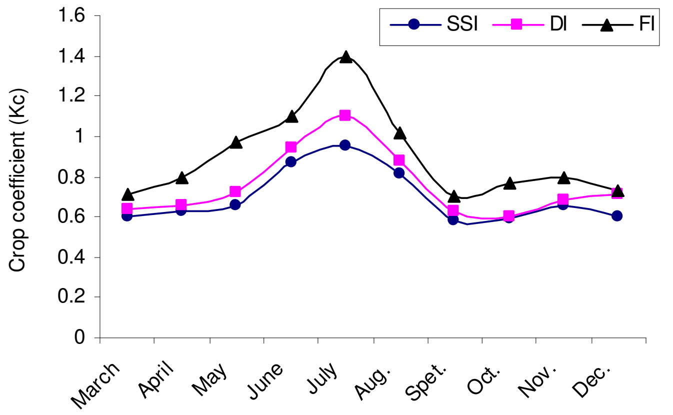

Fig. 6 :The mango orchard cofficient curve for different irrigation systems.

5-Soil moisture distribution:

The soil water content and moisture uniformity in soil profile, before and after irrigation under different irrigation systems, are shown in figures (7 and 8). Data indicated that the moisture content of soil under furrow irrigation (FI) was higher than the drip (DI) and sub-surface irrigation (SSI), after irrigation ,but before irrigation the moisture content of soil under (FI) was lower than for DI and very low from SSI. This was due to increased irrigation interval with FI and uncontrolled quantity of water applied at each irrigation.

Similar trends of soil water content prevailed between DI and SSI, but the SSI was best in uniformity distribution of moisture content in horizontal and vertical directions. Also, the water available was enough in active root zone(allows at field capacity). At the same time, the soil water was very limited in the upper soil surface (at wilting point). That did not help any weed growth .

6-Application water efficiency % :

Irrigation efficiency under different irrigation systems in mango orchard is shown in fig. (9). It is clear that the drip irrigation had high efficiency at the first stage from one year till four years age above sub-surface irrigation and furrow irrigation, respectively. After five years age, the irrigation efficiency under the sub-surface irrigation was higher than drip and furrow irrigations, respectively.

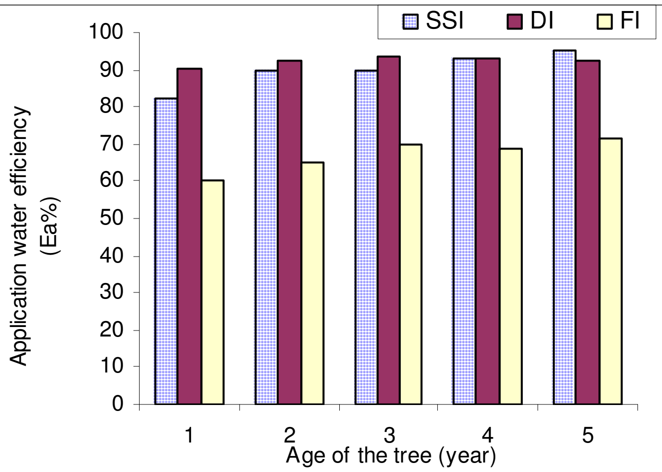

Fig.9 :Application water efficiency for different irrigation systems in mango orchard.

7- Effect of the different irrigation systems on the shot holes split disease of the mango tree.

Effect of the different irrigation systems on the shot split disease in mango orchard is shown in Fig. (10). It is clear that the furrow irrigation causes more the shot holes split than the drip irrigation and sub-surface irrigation. It were 2.7 , 2.1 and 0.06 % under using FI , DI and SSI, respectively. This is duo to, at FI and DI the irrigation water was around the stem, but with SSI the irrigation water can not be reach the soil surface .

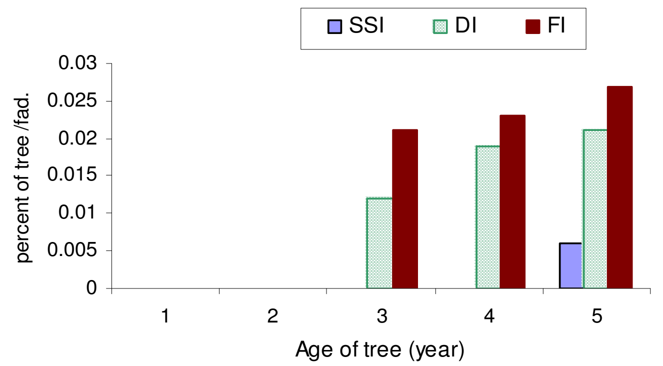

Fig.10 : Effecte of irrigation systems on shot holes split disease of the mango tree.

8-Mango yield :

Fig. (11) show the effect of irrigation methods on mango yield. The data revealed that the average yield of mango under using SSI increased by 13.88% and 26.25% over DI and FI, respectively. The growth performance and irrigation efficiency with SSI are best among other irrigation methods.

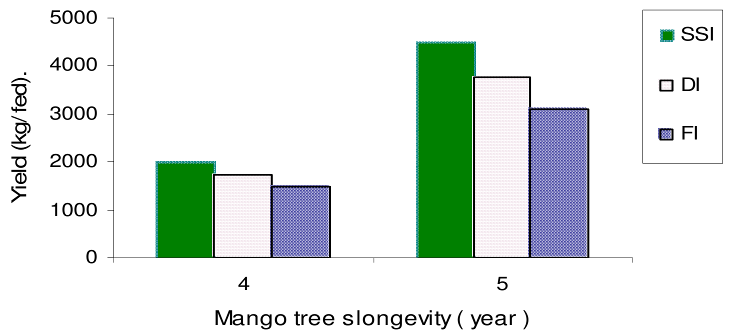

Fig.11: The effect of different irrigation systems on mango yield production.

9-Water utilization efficiency WUE (kg/m^3) :

Water utilization efficiency under different irrigation systems in mango orchard is shown in fig. (12). It is clear that the sub-surface irrigation gave height WUE than drip irrigation and furrow irrigation, respectively. The data revealed that the WUE (kg/m^3) of mango under using SSI increased by 21.86% and 92.32% over DI and FI, respectively.

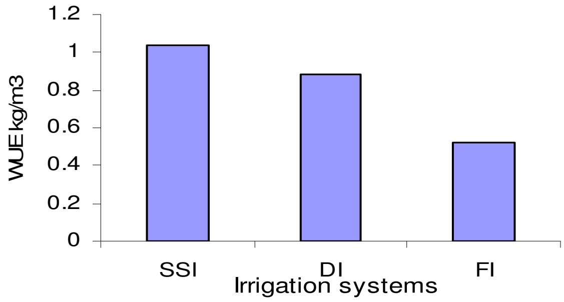

Fig. 12: Water utilization efficiency for mango under different irrigatiom systems .

CONCLUSIONS

1-Growth performance and productivity in mango orchard was best under the sub-surface (SSI) irrigation than drip (DI) and furrow irrigations (FI). This is due to high moisture content distribution uniformity in effective root zone at field capacity, more root length density, inhibition of weeds growth and high irrigation efficiency.

2-Crop coefficients for the mango orchard productive cycle were (Kc = 0.69, 0.74 and 0.85) using SSI, DI and FI, respectively.

3-The furrow irrigation causes the shot split disease more the drip irrigation and sub-surface irrigation. It was 2.7 , 2.1 and 0.06 % using FI , DI and SSI, respectively.

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الملخص العربى

تأثير نظم الرى على النمو والأنتاجية فى بستان المانجو

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المانجو من الزراعات ذات القيمة الاقتصادية العالية ومن السلع التصديرية الهامة، ونظرا للظروف المناخية فى مصر المناسبة لزراعة المانجو فقد انتشرت زراعتها بنجاح فى اماكن مختلفة على مستوى الجمهورية وخاصة فى الأراضى الجديدة. ونظرا للتأثير الشديد لطريقة رى بستان المانجو على نمو وانتاجية الأشجار، فقد اتجه البحث لدراسة أفضل نظم الرى لاعطاء أعلى معدلات انتاج مما يؤدى الى زيادة الدخل القومى. ولتحقيق هذا الغرض، تم اجراء التجارب الحقليه بدءا من زرع الشتلات فى بستان المانجو ولمدة خمس سنوات خلال الفترة من موسم الزراعه فى ٢٠٠٢ الى موسم الحصاد فى ٢٠٠٦ تحت ثلاثة نظم رى مختلفة على النحو التالى :

١- الرىبالخطوط:(FI). عن طريق عمل خط بطول ٣٥م وعرض من ١م يزداد مع عمر الشجرة الى ١,٥م بارتفاع حافة الخط٢٠سم.

٢- الرى بالتنقيط:(DI). خط فرعى بطول ٧٠م وقطر ١٨مم وعدد ٢ نقاط لكل شجرة بتصرف ٤لتر\ ساعه. يزداد التصرف مع زيادة عمرالشجرة.

٣- الرى بالرشح تحت سطح التربة (SSI). حيث تم دفن ٢ خرطوم راشح (٦,٨ لتر| متر طولى\ ساعه عند ضغط ١٥ م) على عمق ٣٥-٤٠ سم من سطح التربة بطول ٧٠ م لكل صف اشجار.

وافادت نتائج البحث على مدار الخمس سنوات بالأتى :

- أعطىالرى تحت سطح التربة أعلى معدلات نمو، حيث زاد ارتفاع الشجرة عن نظم DIو FI بنسبة ١٥,٢ و٢١ % على الترتيب. وزيادة فى محيط الساق بنسبة ٨,٧٥ و ٩,٦ على الترتيب، وهذا راجع الى توفر الرطوبة المناسبة فى منطقة الجذور الفعالة باستمرار .

- توزيع كثافة طول الجذور (سم \ سم^3) لأشجار المانجو اختلفت بين طرق الرى لاختلاف كمية المياه والفترة بين الريات و كذلك توزيع المحتوى الرطوبى تحت كل نظام رى. ففى الرى بالتنقيط ، كانت أكثر المناطق كثافة بالجذور حول النقاطات. أما فى الرى بالرشح تحت التربة، فكانت على امتداد خرطيم الرشح و فى الرى بالخطوط أتجهت الجذور الى العمق اكثر بحثاعن الرطوبة.

- انخفضت نسبة الحشائش تحت نظام SSI بنسبة ٨٤,١ و ٩٣,٥% عن نظامى FI , DI وذلك بسب جفاف سطح التربة على الدوام .

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- كميات المياة المعطاة خلال فترات النمو اختلفت بين نظم الرى، حيث أعطىFI أعلى كمية مياه، يليه SSI ثم DI هذا خلال الثلاث سنولت الأولى. أما فى السنتين الرابعة والخامسة فكانت كميات المياه تحت نظام SSI أقل من DI. ويرجع ذلك الى تحميل محاصيل الخضر معSSI فى السنوات الأولى. أيضا أختلفت كميات المياة لكل شجرة خلال العامْ مع مراحل النمو، حيث اعطت عند مراحل التزهير والعقد والنضج أعلى كميات مياه لكل النظم، ثم انخفض الرى تدريجيا حتى توقف من اخر ديسمبر الى آخر فبراير، باستثناء ريات قليلة جدا للحد من الصقيع.
- معامل المحصول(Kc) تم قياسه خلال دورة الأنتاج فى بستان المانجو، ووجد فى المتوسط ٠,٦٩، ٠,٧٤ و ٠,٨٥ لكل من FI , DI , SSIعلى الترتيب.
- بالنسبة للتوزيع الرطوبى فقد أعطى SSI أفضل توزيع رطوبى فى منطقة الجذور الفعلية للأشجار فى الاتجاهين الرأسى و الأفقى يليهDI ثمFI .
- بالنسبة لكفاءة الرى فقد أعطى DI أعلى كفاءه فى سنوات البستان الأولى نظرا لأمكانية التحكم فى الكميات القليلة المطلوبة للشجرة فى السنوات الأولى. أما مع تقدم الأشجار فى العمر وانتشار المجموع الجذرى، أعطى SSI أعلى كفاءة رى.
- . أعطى SSI اعلى كفائة استخدام للمياة، حيث زاد بنسبة٢١,٨٦ و ٩٢,٣٢% عن نظامى DI وFI على الترتيب.
- بالنسبة لتأثير نظم الرى على الأصابة بمرض تشقق قلف ساق الأشجار فى بستان المانجو فقد أعطى FI أعلى معدلات اصابه يليه DI. اما فى SSI فلم توجد اصابات، وهذا راجع الى تعرض الساق مباشرة للمياة فى طرق الرى السطحية التى تساعد على نمو الفطريات وبعض الحشرات، كما ان الجريان السطحى فى FI يساعد على نقل العدوى من الأشجار المصابة الى السليمة .
- تم حساب المحصول من الثمار الناضجة(كجم\فدان) فى العام الخامس. أعطى SSI اعلى محصول، حيث زاد بنسبة ١٣,٨٨ و ٢٦,٢٥% عن نظامى DI وFI على الترتيب.