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Effect of Irrigation Water Management on Growth of Date Palm offshoots (*Phoenix dactylifera*) under the River Nile State Conditions*

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Abstract: the objective of this study was to investigate the effect of different irrigation water managements on the vegetative growth of date palm offshoots. The experimental work was conducted at the Jordanian Bashair project in the River Nile State, for two consecutive seasons (2007 and 2008). Two irrigation methods were used with three amounts of irrigation water. The irrigation methods were the conventional basin system and two bubbler types, a locally made and an imported bubbler (Rain bird). The amounts of irrigation water were 50%, 75% and 100% of the crop irrigation requirement, as determined by CROPWAT computer model version 2003, using the average of 30 years data. Data were collected on plant height, stem size and number of leaves per offshoot, at age 12 months. The treatment affected significantly ($P< 0.01$) the growth parameters. The imported bubbler gave the highest mean values of growth parameters, while the basin irrigation gave the lowest values. The same result was obtained with 100% Etc, compared with 75 % and 50 % Etc. The interaction of the irrigation system and amount of watering significantly affected the growth parameters. The imported bubbler with 100% Etc gave the highest average values of growth parameters, and basin irrigation with 50% Etc showed the lowest values.

Key words: Date palm offshoots; irrigation systems; watering amount

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INTRODUCTION

Date palm production plays an important role in the economy of the Sudan, particularly in the River Nile State and Northern State. The annual production of dates in the River Nile State is about 27 thousand tons and the average yield is about 30 kg/tree. This productivity is considered very low, and the yield may go up to about 100 kg/tree or more with the right technical packages (Sedig and Abd Al Wahab 1999).

Most of the date palms in Sudan are grown under traditional farming system and are suffering from shortage of irrigation water and, therefore, have few green leaves. Moreover, efficient fertilization depends mainly on irrigation because nutrients are absorbed well when the trees are given sufficient irrigation water. In the Sudan, research on water requirements of the date palm is scanty. Hence, studies on design, implementation and management of water application methods for the date palm are needed. Saeed *et al*. (1990) stated that poor irrigation and water stress significantly depress root elongation and reduce fruit number, size and weight.

Al Amoud *et al*. (2000) conducted a field experiment to investigate the response of date palm trees to different water regimes; namely, 50%, 100% and 150% of date palm water requirement as measured by pan evaporation method, using three irrigation systems: basin, bubbler and trickle. The results demonstrated a general trend of increase in yield with proper watering. The maximum yield was produced under trickle irrigation system followed by the basin system.

Amiri *et al*. (2007) also studied the response of date palm (cultivar Zahdi) under three different irrigation systems: basin, bubbler and sprinkler. Their results revealed that the mean values of the number of leaves per tree, leaf area index, tree height and leaf mineral content are significantly influenced by the irrigation system. They concluded that the general trend was an increase in growth with increase in water availability. Maximum vegetative growth was obtained with the bubbler irrigation followed by basin and sprinkler irrigation.

The objectives of this study were (i) to determine the appropriate irrigation system for date palm offshoots under the conditions of the River Nile State and (ii) to recommend the most suitable amount of irrigation requirements for growth of date palm offshoots.

MATERIALS AND METHODS

The experimental work was carried out at the Jordanian Bashair project, which is located 15 kilometres south of Eldamar town, River Nile State, Sudan (longitude $33^0 50^{/}$'E, latitude $17^0 20^{/}$N and altitude 364 m above m.s.l.), The region is classified as semi-arid with great variation in temperature and rainfall. The weather is very hot in summer with mean maximum temperature of 37^0C, and cold in winter with minimum temperature of 21.8^0C. The soil of the experimental site is sandy clay loam. The experiment was conducted during two consecutive seasons (2007 and 2008) in an area of 4 feddans (1fed. = 0.42 ha) occupied by 200 offshoots at spacing of 8x10 m.

The experiment was arranged in a split plot design with three replications. The irrigation systems were allocated to the main plots and the amount of irrigation water was assigned to the subplots. The date palm offshoots were obtained from tissue culture at an age of about three months, a height of 10 cm and one leaf per plant. Three irrigation systems (basin,: two types of bubblers: imported and locally made) were used each with three different amounts of irrigation water, 50% 75% and 100% of the crop water requirements, as estimated by CROPWAT computer model version 2003.

Bubblers irrigation consisted of a head control unit, filter, pressure gauges, fertilizer injector, pressure regulators and polyvinyl chloride (PVC) distribution network. The distribution network consisted of a main line (16 cm diameter), sub main (6 cm diameter) and 10 laterals per sub main (2.5 cm diameter). Two types of bubbler distributors were installed in the laterals at distances of 8 metres apart and one distributor for each tree. Circular soil basins (2.3 m diameter) were constructed around the base of the tree stem.

Estimation of the date palm water requirement (Etc) was derived from crop evapotranspiration (crop water use) which is the product of reference crop evapotranspiration (ETo) and the crop coefficient (Kc). Reference crop evapotranspiration (ETo) was determined by CROPWAT computer model version 2003, using climatic data. Kc was according to FAO.

$$Etc = ETo \times Kc \times Kr \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

where

Etc = Corp evapotranspiration (mm/day)

Kc = Crop coefficient (dimensionless)

ETo = Reference crop evapotranspiration (mm/day)

Kr = A reduction factor

A reduction factor (Kr) was calculated from the ground cover value (GC). It is defined as the fraction of the total surface area actually covered by the foliage of the trees when viewed directly from above. In order to calculate GC, the diameter of shaded area in centimetres (cm) was taken after mid day.

The ground cover, as percentage, was calculated by the procedure described by Hellman (2004) as follows:

Area per tree = Row width x tree spacing within row

Shaded area per tree = Tree spacing within row x D

$$GC(\%) = \frac{\text{Shaded area per tree}}{\text{Area per tree}} \times 100 \quad \ldots\ldots\ldots \text{(2)}$$

where

D = Average width of measured shaded area between two trees

GC = Ground cover (%)

The reduction factor (Kr) was estimated using equation (3) as suggested by Keller and Bliesner (1990) and Esmail (2002):

$$Kr = 0.1GC^{0.5} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

where

Kr = The reduction factor

GC = Ground cover (%)

The amounts of water were measured by flow metres, which were fixed to the sub main lines, and the readings were taken at each irrigation event. Flow controls were used to control the amount of water delivered to the laterals. The basin irrigation water was measured volumetrically (Micheal 1978).

Average values of plant growth, number of leaves, plant height and stem diameter were measured and recorded, at the age of 12 months.

RESULTS AND DISCUSSION

Methods of irrigation had positive effect on number of leaves per plant, plant height and stem diameter (Table 1). The highest mean values were obtained with the imported bubbler, and the lowest values were recorded for the basin irrigation system. The superiority of bubblers over basin irrigation may be attributed to the fact that bubblers provide the crop with adequate water requirement. These results are in conformity with those obtained by Bhardwaj *et al*. (1995), Al Amoud *et al*. (2000), Abd El Aziz *et al*. (2005) and Amiri *et al*. (2007).

The offshoot growth parameters were significantly affected by the amount of water (Table 2). The highest mean values were obtained with 100% Etc, followed by 75% Etc and 50% Etc. This may be due to fact that water applied at 100% Etc adequately meets the crop water requirement, while the other amounts did not. This result is in agreement with the findings of Hussein and Hussein (1983) and Wahba *et al*. (1990).

Table 1. Effect of irrigation system on the offshoot growth of date palm

Irrigation system	Plant parameter		
	No. of leaves/plant	Plant height (cm)	Stem diameter (cm)
Imported bubbler	39[a]	176.4[a]	21.7[a]
Locally made bubbler	37[ab]	151.6[b]	19.0[b]
Basin	30.3[b]	144.9[b]	15.6[c]
LSD (0.01)	4.4	22.6	1.7

Means with the same letter(s) in the same column are not significantly different at P≤ 0.01.

Table 2. Effect of amount of irrigation water on the offshoot growth of date palm

Watering amount (% of Etc)	Plant parameter		
	No. of leaves/plant	Plant height (cm)	Stem diameter (cm)
100	38.6[a]	173.4[a]	20.1[a]
75	35.1[b]	157.1[b]	19.2[ab]
50	31.7[c]	134.0[c]	17.0[b]
LSD (0.01)	0.82	13.1	1.7

Etc = Crop water requirement

Means with the same letter(s) in the same column are not significantly different at P≤ 0.01.

As shown in Figures 1 and 2, the interaction between irrigation systems and amounts of irrigation water affected the offshoot growth parameters.The imported bubbler gave the highest number of leaves per plant, plant height and stem diameter at 100% Etc followed by the locally made bubbler, while the basin irrigation at 50% Etc had the lowest values. On the other hand, plant growth increased with increase of the total water amount. Similar results were reported by Makki and Mohamed (2005).

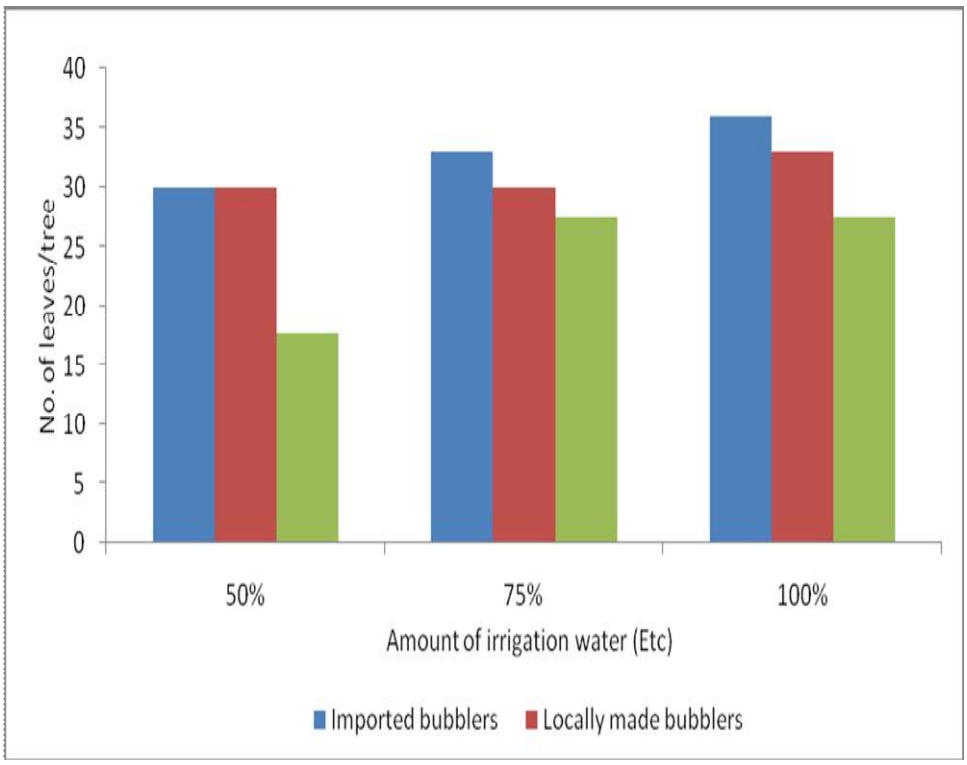
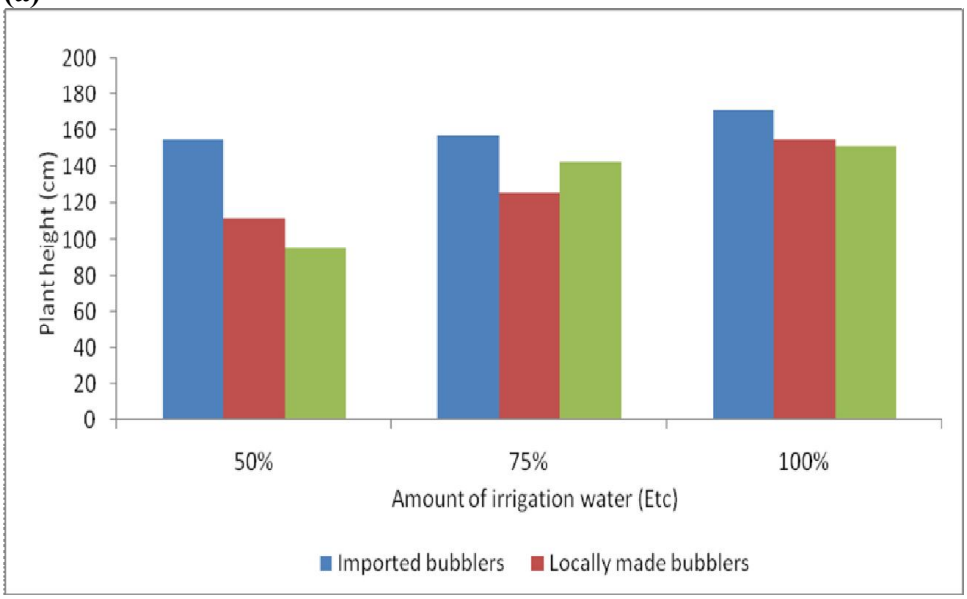


Fig.1. Effect of irrigation system and amount of water on the number of leaves/tree

(a)



(b)

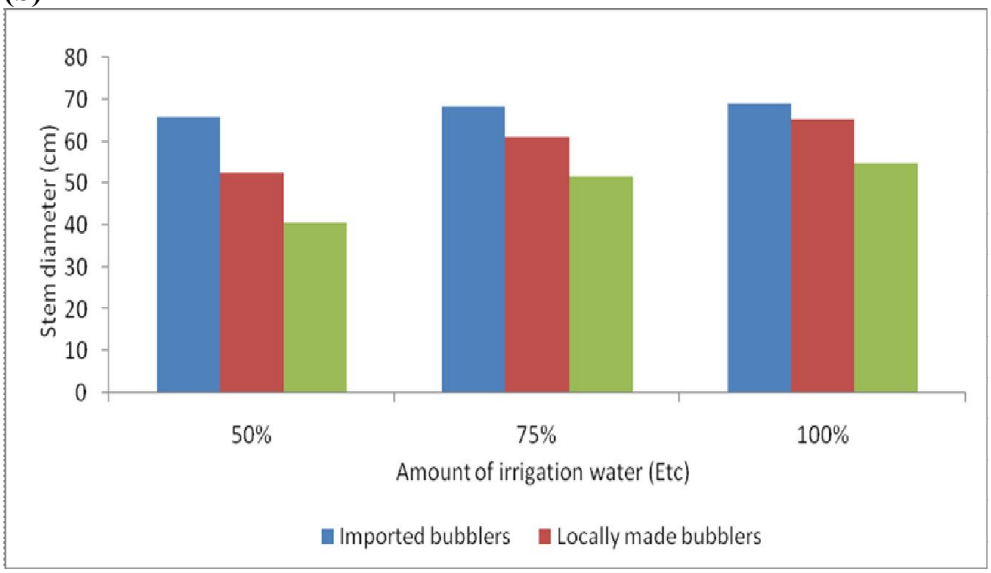


Fig. 2. Effect of irrigation system and amount of water on (a) plant height and (b) stem diameter

CONCLUSION

Imported bubblers irrigation system is the most suitable irrigation system for date palm offshoots in the River Nile State, as 100 % Etc can be guaranteed.

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تأثير إدارة مياه الري على نمو فسائل نخيل البلح تحت ظروف ولاية نهر النيل*

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المستخلص: هدفت هذه الدراسه لبحث تاثير إدارات مختلفه لمياه الري علي النمو الخضري لفسائل نخيل البلح. أجريت التجارب بولاية نهر النيل (مشروع بشائر الأردني) خلال موسمي 2007 و2008. إستخدمت طريقتان للري هي الري بالأحواض التقليدي و نوعين من الري الموضعي هما الفقاعي المصنع محليا والفقاعي المستورد، مع ثلاث كميات لمياه الري هي 50% و 75% و100% من المتطلبات المائيه للمحصول و التي تم تحديدها من معلومات للثلاثين سنه الماضيه باستخدام برنامج الحاسوب CROPWAT اصدار 2003. جمعت بيانات عن طول النبات و حجم الساق وعدد الأوراق بكل فسيله. أظهرت النتائج تأثيراً إيجابيا علي عوامل النمو. أعطي الفقاعي المستورد أعلي متوسط قيم لعوامل النمو ، بينما الري الحوضي أظهر أقل قيم للنمو. نفس النتائج تم الحصول عليها مع كميه المياه 100% مقارنة مع 75% و 50%، من بخرنتح المحصول. أظهرت نظم الري مع كميات مياه الري تأثيرا إيجابيا علي عوامل النمو، وأعطي الفقاعي المستورد مع الكميه 100% من البخرنتح أعلي قيم بينما الري الحوضي مع الكميه 50% من البخرنتح أظهر أقل متوسط قيم لعوامل النمو.

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