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Effect of Bubbler Irrigation Interval on Yield and Water Productivity of Date Palm Cv. Barhee Under Khartoum State Conditions, Sudan

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ABSTRACT: The experiment was conducted in the private orchards at Tayba Alhasnab area of south Khartoum, Sudan during 2013 and 2014 to study the effect of bubbler irrigation interval on yield and water productivity of date palm under Khartoum State conditions. Five different bubbler irrigation intervals were applied at 3, 5, 7, 9 and 12 days. Treatments were replicated three times in randomized complete block design (RCBD) and each plot encompassed 3 trees. The results showed that higher yield and yield components were obtained with 5 days irrigation interval in both years. Moreover, bubbler irrigation interval every 5 days had highest values of water productivity and economic water productivity.

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KEYWORDS: Date palm, Bubbler irrigation, Irrigation frequency, Water productivity, yield components.

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I. INTRODUCTION

Irrigation is particularly critical for agricultural production in arid and semi-arid agricultural areas where water resources are scarce.

Water management will continue to be one of the major factors affecting crop production. The great challenge of the agricultural sector is to produce more food from less water, which can be achieved by increasing crop water productivity (Zwart and Bastiaanssen, 2004). Higher pumping costs, water restriction and water shortage are all factors encouraging efficiency-improving irrigation practices. Irrigation systems significantly affected only mean overall production of date and seed weight Alla et al, (2021)

Bubbler irrigation is a combination of surface and drip irrigation that needs a small basin, because the discharge is too high, 50 to 225 liters per hour and it is usually used for orchard and big trees (Ismail, 2002). In this regard, Ibrahim *et al*. (2012) reported that bubbler irrigation gave the highest mean values of growth parameters on date palm, while the basin irrigation gave the lowest values. Kabeel et al. (2013) concluded that irrigation "Le-Conte" pear trees with bubbler irrigation system was the best and the most effective irrigation system as compared to another irrigation system (surface) for increasing tree productivity and improving fruit characteristics.

Irrigation intervals is one of the most important factors in irrigation management because of its effects on soil water regime, root distribution around the emitter, amount of water uptake by roots and the amount of water percolation under the root zone (Wang *et al*., 2006). Date palm is high water consumption and has widespread roots. The average daily Date Palm water use was 184.4 l/day for all regions in KSA and the total net annual date palm water use has ranged between 59.4 and 80 m3/tree Alamoud, *et al*. (2012). Mattar (2021) reported that the farmers must improve water management systems to maintain the optimal production level. Date palm ***(Phoenix dactylifera L.)*** is a major crop in most arid and semi-arid regions of the world Abd Elgawad, *et, all*. (2019). Therefore, the objective of this study was to examine the effects of bubbler irrigation interval on yield and water productivity of date palm cv. Barhee under Khartoum State conditions.

II. MATERIALS AND METHODS

The experiment was established in a private orchard at Tayba Alhasnab area, Khartoum, to evaluate the effect of bubbler irrigation interval on yield and quality of date palm cv. Barhee. A bubbler irrigation system was installed in the laterals at distances

of 8m apart and one distributor per tree with discharge of 100 l/h. Five bubbler irrigation intervals were applied at 3, 5, 7, 9 and 12 days. Treatments were replicated 3 times in randomized complete block design (RCBD) and each plot encompassed 3 trees. The spacing of date palm tree was 8×8m (156 date palm trees/ha).

The crop water requirement for every irrigation interval was calculated using the following equation according to Allen, *et al*. (1998).

$CWR = ET_c \times (3, 5, 7, 9 \text{ and } 12 \text{ days})$ …… (2)

The overcome losses in discharge the gross depth (dg) was calculated using the following equation:

$$dg = \frac{ET_c \text{ mm}}{EU} \text{……..} (3)$$

Where: -

EU= emission uniformity (90%).

Volume of water for bubbler irrigation was applied in liter/plant using the following equation:

$V = A \times AW \times dg$…… (4)

Where: -

V = Volume of water in liter per plant, A = Plant area (Row spacing m × Plant spacing m), Aw% = Wetted area (0.3) and dg = Net depth required, mm.

Time of irrigation was calculated using the following equation:

$$\text{Time of irrigation} = \frac{\text{Volume of water to be applied (liter)}}{\text{Bubbler discharge rate (l/h)}} \text{……...} (5)$$

The special horticultural practices for the of date palm were carried out as recommended.

Yield per tree was recorded in kg/tree and t/ha. Ten fruits were collected randomly for determination fruit length (cm) and fruit weight (g).

Water productivity (WP) was estimated using the following equation:

WP = Yield/TAW …… (6)

Where:

Yield in kg and TAW is total applied water in m^3.

Economic water productivity (EWP) was calculated as the gross income in Sudanese Pounds (SDG) per gross water supplied in m^3 using the following relation:

EWP = GI/GIWR…… (7)

Where:

GI is the gross income from the sale of product (SDG/ha) and GIWR is the gross irrigation water applied (m^3/ha).

Crop Stat statistical program was used for data analysis and the least significant difference range test was used for mean separation at the probability level of 0.05.

III. RESULTS AND DISCUSSION

Effect of bubbler irrigation interval on yield (kg/tree) and total yield

Yield showed very highly significant differences in both years (Table 1). The highest yield was 127.7 and 147.7kg/tree under 5 days irrigation interval, followed by 106.7 and 128.3 kg/tree under 7 days irrigation in the two years respectively, as compared to the 12 days. The result indicated that date palm yield was affected by irrigation interval. This might be due to irrigation interval keep soil moisture at the optimum level, thus improving growth and increasing productivity. These findings agree with the results obtained by Bagali, *et al*. (2012) who found that irrigation scheduled at one day interval recorded significantly higher bulb yield over three days interval. Moreover, El-Abd, (2012) who found that the highest yield as kg/tree on navel orange was recorded under a high irrigation frequency. Similar results were reported also by Khalifa, *et al*. (2017) who reported that 5 days irrigation frequency increased total yield of foster grapefruit by 39% and 8% in the first and second year, respectively, as compared to the 12 days.

Table 1. Effect of bubbler irrigation interval on yield (kg/tree) and total yield (t/ha) of date palm under Khartoum State conditions.

Irrigation interval	Yield (kg/tree)		Yield (ton/ha)	
	Year 2013	Year 2014	Year 2013	Year 2014
3 days	97.0c	114.7 c	15.1	17.9
5 days	127.7a	147.7 a	19.9	23.0
7 days	106.7b	128.3 b	16.6	20.0
9 days	90.0d	109 c	14.0	17.0
12 days	87.0d	97.2 d	13.6	15.2

SE±	1.33	2.4	-	-
CV%	18.3	13.5	-	-
Significance level	***	***	-	-

******: indicated significance at P≤ 0.001.***

Effect of bubbler irrigation interval on fruit weight and fruit length

Bubbler irrigation interval showed highly significant differences between treatments on fruit weight and there were no significant differences in fruit length in both years (Table 2). The highest fruit weight was obtained with 5- and 7-days irrigation interval in both years (Table 2). This might be due the frequent irrigation through favoring higher nutrient uptake and enhancing fruit quality. These results are in agreement with those Khalifa, *et al*. (2019) who indicated that the bulb diameter was significantly affected by irrigation intervals. On other hands, Bagali, *et al*., (2012) found that scheduling of drip irrigation of onion at shorter intervals significantly increased the bulb weight and diameter. Moreover, Khalifa, *et al*. (2017) found that bubbler Irrigation frequency had significant effects on fruit weight of foster grapefruit in both seasons.

Table 2. Effect of bubbler irrigation interval on fruits weight (g) and fruit length (cm) of date palm under Khartoum State conditions.

Irrigation interval	Fruits weight (g)		Fruits length (cm)	
	Year 2013	Year 2014	Year 2013	Year 2014
3 days	10.7b	10.9 bc	3.1	3.3
5 days	11.6a	11.6 a	3.4	3.4
7 days	11.5a	11.5 a	3.5	3.4
9 days	10.7b	11.2 ab	3.4	3.4
12 days	10.1c	10.5 c	3.4	3.2
SE±	0.20	0.14	0.73	0.82
CV%	13.2	12.2	13.8	14.3
Significance level	**	**	NS	NS

***** and NS: indicated significance at P≤ 0.01 and no significant respectively.***

Effect of bubbler irrigation interval on water productivity and economic water productivity

Values of water and economic productivities were increased with irrigation interval until 5 days and then decreased. Our results indicate that highest water and economic productivities were optioned with the 5 days irrigation interval in both years (Fig .1 and 2). This might be due to the less evaporation or runoff under bubbler irrigation system. These results are in agreement with those reported by Kassem, (2008) who found that high frequency irrigation enhanced field water use efficiency (FWUE) and crop water use efficiency (CWUE).

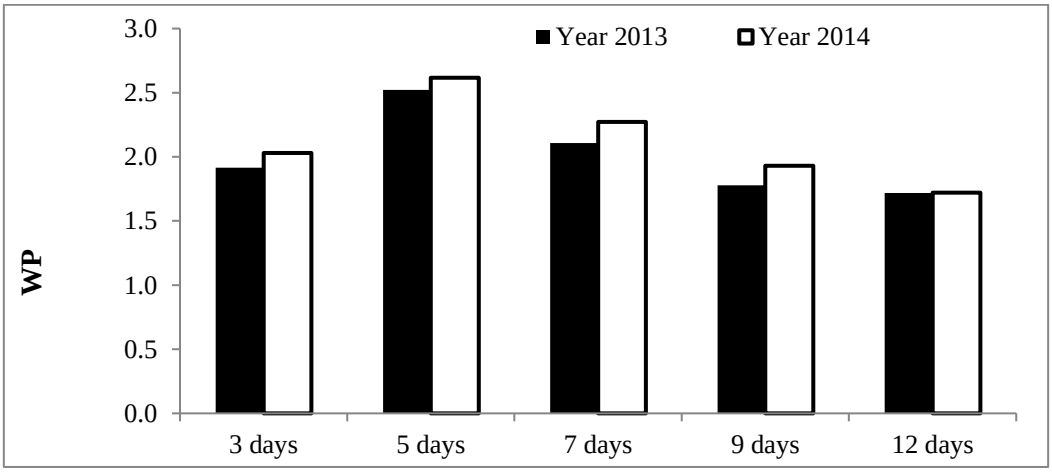

Figure 1. Effect of bubbler irrigation interval on water productivity (WP) (kg/m^3) of date palm irrigated under Khartoum State conditions.

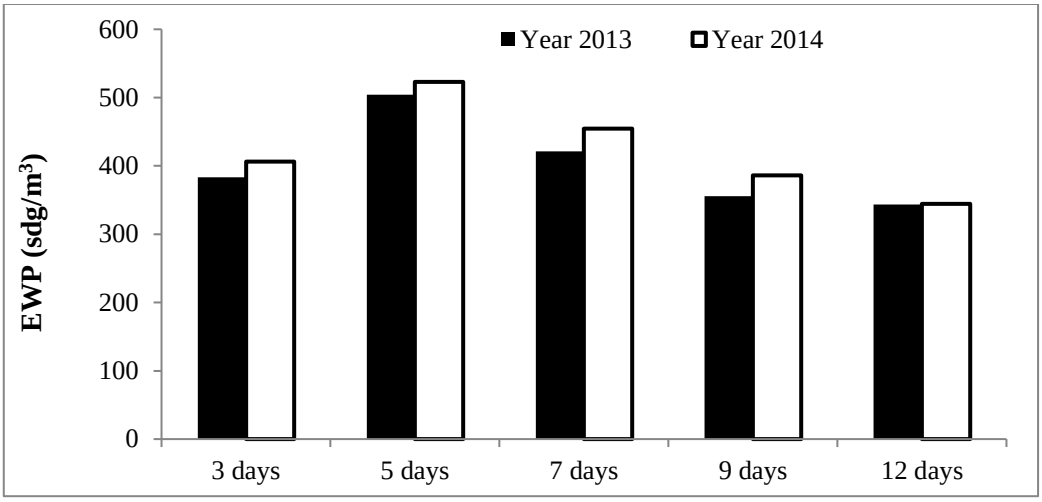

Figure 1. Effect of bubbler irrigation interval on water productivity (WP) (kg/m3) of date palm under Khartoum State conditions.

IV. CONCLUSION

The highest yield, yield components, water productivity and economic water productivity were obtained **for the high irrigation frequency (5 days) compared to low irrigation frequency (12 days)**.

V. ACKNOWLEDGEMENTS

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VI. DISCLOSURE

The author reports no conflicts of interest in this work

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