GROWTH RESPONSE OF PALM TRESS TO THE FREQUENCY OF IRRIGATION BY BUBBLERS IN KHUZESTAN, IRAN

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ABSTRACT

Based on the shortage of water resources in Iran and the high evapotranspiration rate in Khuzestan region (2044 mm/year), an irrigation system on Estamaran palm tree in the Experimental Farm of Shahid Rajaee of Omidiyeh plain was conducted.

This study had two purposes, namely irrigation frequency and suitable depth of irrigation application of the Estamaran palm trees in Omidiyeh region. This study had two objectives. Irrigation frequency was the primary treatment and the evapotranspiration estimating methods was the secondary treatment. Three irrigation levels. i.e. one day long (A1), two day long (A2) and three day long (A3), were used as irrigation frequency. Also the evapotranspiration estimating methods used were, Penman-Montith 100% (B1), Penman- Montith 70% (B2), class A pan 100% (B3) and class A pan 70% (B4). Since this study had three replications, 36 palm trees were selected for this experiment. Cropwat software V.4 for windows, was applied for the evapotranspiration estimating from Penman-Montieth method. Irrigation scheduling was done according to SCS recommendations. Experimental design was according to split plot method in a randomized block. Finally by measuring the different growth indices of palm trees (leaf number, barb number and leaflet length) at a definite time, the best treatment was determined. The results showed that as a whole all the treatments in this experiment did not show a significant difference (up to 5% level) for the indicated indices. However, at the end of 4 month since the beginning of this study, the growth indices of trees in A2B1, A1B2 and A1B1 increased compared to other treatments. The result also indicated that, A1B2 was the best treatment of all. In comparison with the traditional irrigation by local farmers, using A1B2 treatment for all the palm trees (from Aug to Nov), will have 28422.34 m^3 water saving in 3.87 hectare per month.

INTRODUCTION

Yearly total rainfall received on the surface in Iran is about 400 billion, cubic meters (BCM), out of which 280 BCM is lost through evapotranspiration and the remaining 120 BCM is either surface runoff or infiltrates to raise soil moisture or join groundwater. A third of the total surface water of the country (about 34 BCM) flows through rivers passing the vast Khuzestan plain (3,6). However the total cultivable land area of Khuzestan exceeds 1.6 million ha,. out of which,

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540,000 ha is under irrigation. Total area under modern irrigation in Khuzestan is at present 238,320 ha. and is planned to finally reach 800 thousand hectars, under modern irrigation projects (1,8,12)

The Soil and Climate of Khuzestan is suitable for diverse agronomic and horticultural farming throughout the year and produces about 14 percent of the total agricultural production of the country (12). One of the major crops in this province is date palm. Although this crop is adapted to dry conditions, higher yields can be obtained with irrigation. With about 30 million palm trees covering a total area of 216 thousand hectares, the total date production in Iran is about 900 thousand tons. In spite of the importance of this crop, so far little is known about the potential of raising yield for this crop through modern irrigation research (9).To determine the proper irrigation depth and interval for Estamaran date palm trees grown on Omidieh experimental field, this field research experiment was designed.

MATERIALS AND METHODS

This research started on February 20, 2005 and continued unit the end of November 2006. The experimental site is a 50 hectare field in Omidieh, located south east of Khuzestan, 180 KM from the central city of Ahwaz. The mean annual rainfall in Omidieh is about 266 mm. The experiment was designed as split plot based on complete randomied blocks (CRB) with 12 treatments and 3 replications (total number of 36 trees). The main variable factor was irrigation frequency taken at 3 levels; daily (A1) , two day (A2) and three day (A3) intervals. The secondary variable factor was the method of estimation of the depth of irrigation applications based on Penman -Montieth (100%) (B1), Penman-Montieth (70%) (B2) Class A pan 100% (B3) and class A pan 70% (B4).

Irrigation water is carried through a 90 mm submain, feeding a number of 32mm manifolds. Laterals take water from these manifolds and delivers water to the bubblers beside palm trees grown at a spacing of 8m×8m. A round basin is dug around every tree about 1.5m in diameter .The soil of the experimental site was a sandy loam with a PH of about 8 and ECe of 1.8 ds/m. Final intake rate of soil was 6-8 mm/h which improved by the addition of organic matter to basins. EC of irrigation water was measured to be 2.71, 2.75, 2.86 and 2.91 ds/m for the end of July, August, September and October.

- Preparations before starting irrigation included:
- Separating the selected trees
- Separating female pods for pollination
- Weeding
- Pruning and cutting
- Manuring with fertilizer application
- Marking and tagging leaflets and thorns for growth measurement.
- Calibration of bubblers for a fixed discharge of 222 liters / hour with an inlet pressure of 2.5 bars.

Irrigation water requirement of palm trees was calculated using climatological data of the period 2000-2004 and potential evapotranspiration of reference crop ETo, estimated with pan evaporation record according to the following :

ETo = Kp Epan

Kp = pan Coefficient
Epan = pan evaporation mm/day

Kp= 0.475 – 0.24 *10-3 (U2m)+0.00516 (RHmeam)+0.00118(d)-0.16×10-4 (RHmean)2
-0.101×10-5(d)2 – 0.8 ×10-8 (RH mean)2(U2m) - 1×10-8(RHmean)d
-1×10-8(RH mean)2 d

Where

U2m = wind speed at 2m height (Km)
RH mean = mean relative humidity %
d = Green fetch area m

ETo was also estimated by Penman Montieth method, using computer software (Cropwat 4, Ver. 4.2) (10). A crop coefficient (Kc) of 0.9 was used for date palm . Effective rainfall was estimated using 80% probable mean monthly rainfall.

$$Pe = [1.252496 \times p_m^{0.82416} - 2.93522] \times 10^{(0.00095512 \times ETc)}$$

Pe = effective rainfall (mm/month)
Pm = mean rainfall mm/month
ETc = potential evapotranspiration

We also have :

Pe (80%)= pe * 0.66

Considering that in drip irrigation soil surface evaporation losses are minimal and almost all the water consumed is lost by transpiration, calculation of mean daily transpiration of date palm is given by

Td = Ud [Ps/100 + 0.15 (1-ps/100)]

Td=mean maximum daily transpiration (Corrected with 80% effective rainfall)

Ud=mean maximum daily consumptive use
Ps=percent plant cover
(Table 1.)

Net depth of irrigation application (In) is derived as:

In = T * Fi
(Table 2.)
Mean maximum irrigation requirement (Ig) is estimated by

Ig = (In* Tr) / (Ea/100)

Tr = Transpiration ratio during peak period
Ea = Irrigation Efficiency or

Ea= Eu × Et

Eu= Uniformity of dripping
Et = Crop water use efficiency

Table 1. shows that during November-December and December-January, 80% probable monthly effective rainfall exceeds mean maximum monthly transpiration for date palm , therefore there was no irrigation application for this period. It was assumed that due to resistance to moisture stress, date palm trees can overcome the nonuniformity of rainfall without reduction in growth.

Table 1. Water requirement of treatments from July to January

month	ETc & Td (mm/day) and Pe80% (mm/month)											
	Penman-Montith 100%			Penman-Montith 70%			Class A Pan 100%			Class A Pan 70%		
	ETC	Td	Pe80%	ETC	Td	Pe80%	ETC	Td	Pe80%	ETC	Td	Pe80%
J-A	16.23	3.5	-	11.36	2.45	-	6.72	1.45	-	4.71	1.01	-
A-S	15.05	3.24	-	10.53	2.27	-	5.19	1.12	-	3.64	0.78	-
S-O	11.38	2.45	-	7.96	1.71	-	4.23	0.91	-	2.96	0.64	-
O-N	8.3	1.79	8.5	5.8	1.25	7.21	2.43	0.52	5.8	1.7	0.37	5.5
N-D	3.98	0.86	38.07	2.79	0.6	35.19	1.32	0.28	31.94	0.93	0.2	31.13
D-J	2.9	0.62	36	2.02	0.43	33.96	1.03	0.22	31.81	0.72	0.15	31.17

Table 2. Net depth of irrigation for all the treatments

A3B4	A3B3	A3B2	A3B1	A2B4	A2B3	A2B2	A2B1	A1B4	A1B3	A1B2	A1B1	Treatments
3.03	4.35	7.35	10.5	2.02	2.9	4.9	7	1.01	1.45	2.45	3.5	July-Aug
2.34	3.36	6.81	9.72	1.56	2.24	4.54	6.48	0.78	1.12	2.27	3.24	Aug- Sep
1.92	2.73	5.13	7.35	1.28	1.82	3.42	4.9	0.64	0.91	1.71	2.45	Sep-Oct
0.57	0.99	3.03	4.53	0.38	0.66	2.02	3.02	0.19	0.33	1.01	1.51	Oct-Nov

Gross daily requirement of a crop in liters per day is estimated by the following equation:

G=(Ig/Fi) × Sp × Sr
Where

Sp = distance between trees in each row
Sr = distance between rows of trees
(Table 3.)

Table 3. Gross depth of irrigation from July to November (mm)

month	A1B1	A1B2	A1B3	A1B4	A2B1	A2B2	A2B3	A2B4	A3B1	A3B2	A3B3	A3B4
J-A	4.47	3.13	1.853	1.29	8.94	6.26	3.71	2.58	13.42	9.39	5.56	3.87
A- S	4.14	2.9	1.43	1	8.28	5.8	2.86	1.99	12.42	8.7	4.29	2.99
S-O	3.13	2.18	1.16	0.82	6.26	4.37	2.33	1.64	9.39	6.55	3.49	2.45
O-N	1.93	1.29	0.42	0.243	3.86	2.58	0.84	0.49	5.79	3.87	1.26	0.73

Time of water application, Ta, in hours is calculated with the following equation:

$Ta = G/ (Np \times qa) \times Fi$

Where

Np = number of drippers surrounding a tree
qa = drippers discharge l/h

RESULTS AND DISCUSSION

Daily gross water requirement for all the treatments is given in Table 4.

Table 4: Daily gross water requirement for all treatments

Treatments	Lit/day , G			
	July-Aug	Aug-Sep	Sep-Oct	Oct-Nov
$A_{1,2,3}B1$	286	265	200	124
$A_{1,2,3}$ B2	200	186	140	83
$A_{1,2,3}$ B3	119	92	74	27
$A_{1,2,3}$ B4	83	64	52	16

The record keeping activity started on July 23 and the last measurement took place on November 22. As seen from the table of measured characteristics from each treatment, no changes were observed until Oct 23 and only slight changes were noted on November 22. Analysis of data collected from all the treatments was performed with Spss 13. for Windows and the table of analysis of variance for each crop characteristics in each treatment was constructed.

According to the results of the analysis of variance for all the variations in crop characteristics including number of leaves, thorns, length of leaf in the 4 month period of experiment, did not show to be significant at 5% level. This was due to drought resistance of palm tree and its slow

growth rate, which masks the appearance of growth indicators during this short period. Besides the above discussion about the significance of growth characteristic indices, as seen from the tables of measured characteristics of different treatments during the fourth month of this experiment, growth factors in the treatment A1 B1, A1B2 and A2 B1 , were more comparable to other treatments. Among those treatments A1B2 (Penman - Montieth 70% and daily irrigation) was the most appropriate treatment.

Selection of this treatment to be the most appropriate treatment compared to A2B1 and A1B1, is due to the fact that with the same amount of growth, the above treatment had received less water. Therefore it can be concluded that this treatment can lead to a better water use efficiency of date palm in Omidieh. Recommendation of (A1B2) treatment as the most appropriate for date palm growers will result in a saving of about 28422.34 m3 in 3.87 hectare per month compared to routine practices in the area (Table 5). Total number of date palm trees in the whole field was 610 and bubblers with a bubbler discharge of about 750 liters/hr and irrigation application interval of 2 days in July – August and 3 days in October-November was performed. In a series of research conducted by the Work Group of Agricultural Products of Iran (WGAPI), Penman - Montieth method was compared with FAO24, Corrected Penman, Radiation and Blany Criddle method, for many weather stations (9).

Table 5: Comparison of the water requirement of A1B2 treatment with routine irrigation practice for the same area of 3.87 hectare

Irrigation frequency and depth	Total water volume cubic meters for 3.87 hectares			
	July-Aug	Aug-Sep	Sep-Oct	Oct-Nov
A1B2 treatment	3782	3517.26	2562	1518.9
Routine irrigation practice (frequency & depth that is presently performed on the farm)	14182.5	14182.5	6862.5	4575

Penman - Montieth was selected as the most appropriate method and gave the lowest ET0. Therefore we conclude that ETo by pan evaporation method can be used more advantageously in Omidieh which is a dry region. It can be concluded that for Estamaran date palm in Omideh region, if enough water is available treatment (A1B2) is recommended. Otherwise with less water available treatments using pan evaporation are more appropicate.

Table 6: Comparison of reference potential evapotranspiration by Penman-Montith and Class A Pan in Omidiyeh

Method of estimation	Reference crop potential evapotranspiration mm/day					
	July-Aug	Aug-sep	Sep-Oct	Oct- Nov	Nov-Dec	Dec-Jan
Penman Montith	18.03	16.72	12.64	9.21	4.42	3.21
Class A Pan	7.47	5.77	4.7	2.7	1.47	1.14

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