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THE RESPONSE OF PALM TREES TO BUBBLER IRRIGATION SYSTEM UNDER EL-WADI EL-GEDED GOVERNORATE CONDITION

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ABSTRACT

The main objective of this study was to determine an appropriate water management consideration of bubbler irrigation system for palm trees "age four years" (*Phoenix dactylifera*) under El-Wady El-Geded Governorate. Therefore, the three bubbler nozzles were comparing with Conventional irrigation system Basin irrigation system in two successive growing seasons(2013-2014) and (2014-2015). Results revealed that water saving of about observed under bubbler irrigation systems comparing with basin irrigation system.

1. INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is playing an important role in the Egyptian agriculture and represents a significant part in the reclamation programme. Besides the nutritional values and health benefits of the fruits, the date palm by-products are daily used by Egyptians. Adaptation of date palm to water stress made it as one of the first fruit trees distributed and taken into cultivation in arid and semi-arid regions of Egypt. (**Shawky, 2013**). However, Egypt is one of the main producers of date with annual production reaching 1,100,000 tons, the average yield of the date palms is about 102 kg/palm calculated on the bases of bearing palms, this figure is very high compared to the world average that is of about 50 kg/ palm **(FAO, 2008)**.

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Date palm tree are grown under different macro and micro climate regions of Egypt. The total number of planted palm trees in Egypt is 16 million including 12 million fruiting tree **(FAO STAT, 2009).**

Yassir et al (2012) studied the response of data palm under two irrigation systems were the conventional basin and bubbler irrigation systems (imported and local bubbler). The studied amounts of irrigation water were 50%, 75% and 100% of the crop water requirements. The imported bubbler with 100% Etc. gave the highest average values of properties parameters, and basin irrigation with 50% Etc. showed the lowest values. **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) 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 are index, tree height and leaf mineral content are significantly in fluenced by the irrigation system.

Adel et al (2011) stated that the date palm wilt disease (sudden decline syndrome) in Pakistan, the isolation and identification of the pathogens from infected different parts of date palm trees (root-fronds and trunks). The preliminarily results showed that the pathogens was the soil born fungus Fusarium solani was the predominate fungus isolated in very high frequency followed by Phoma unladium and Helminthosporium sativum. The majority of the infected trees were found planted on the terraces of irrigation canals or at area with low level land. For garden periodical irrigation with enough quantity or water according to climate conditions, soil.

The main objective of this study were to

Determine an appropriate bubbler system for palm trees in El-Wady El-gedid governorate and study the effect of using selected bubbler and basin irrigation system on vegetative proprieties for date palm.

2. Materials and Methods

2-1 Materials

2-1-1 Location

- The laboratory works were carried out in Hydraulic Laboratory of Agricultural Engineering Department Faculty of Agriculture Ain Shams University.
- The field was carried out in El-Dakhla, distinct El-Wadi El-Gedid at private farm with area of 2 fed.

2-1-2. Analysis soil and irrigation water

Soil and irrigation water analysis were conducted according to standard procedures and represented in **Tables (1 and 2).**

Table 1. Some physical properties of El-Dakhla site

Soil depth, cm	Particle size Distribution, %				F.C. %	W.P. %	B.D. g/cm3	Texture class
	coarse Sand	fine Sand	Silt	Clay				
0-30	8	38	5	3	26	8	1.68	Sand
30-60	9.2	35.6	5.2	4.5	27	9	1.62	Sand
60-100	9.1	34.2	8.5	2.5	28	9	1.7	Sand

Table 2. Some chemical data of irrigation water at Sl-Dakhla site

pH	EC dS/m	Soluble Cations, meq/L				Soluble Anions, meq/L			SAR
		Ca++	Mg++	Na+	K+	HCO3-	SO4--	CL-	
6.9	9.66	2.303	2.142	4.872	0.31	0.836	2.661	6.09	3.27

2-1-3 Irrigation system Fig. (1)

Irrigation system consisted of a water source, control head and (PVC) distribution network The distribution network consisted of:

Bubblers

Used three nozzels of bubbler that:

- Imported bubbler 1 (Bubbler A), at nominal operating pressure.
- Imported bubbler 2 (Bubbler B), at nominal operating pressure.
- Local bubbler (Bubbler C), at nominal operating pressure.

It was used two bubblers each tree that flow of bubbler 60 L/H.

2-1-4 Crop data

Date palm crop (Phoenix dactylifera) at four age, total area of tree equals (8*8) m2. Date palm crop coefficient and root depth (2m) are shown in **Table (3),** and climatic data shown in **Table (4)**.

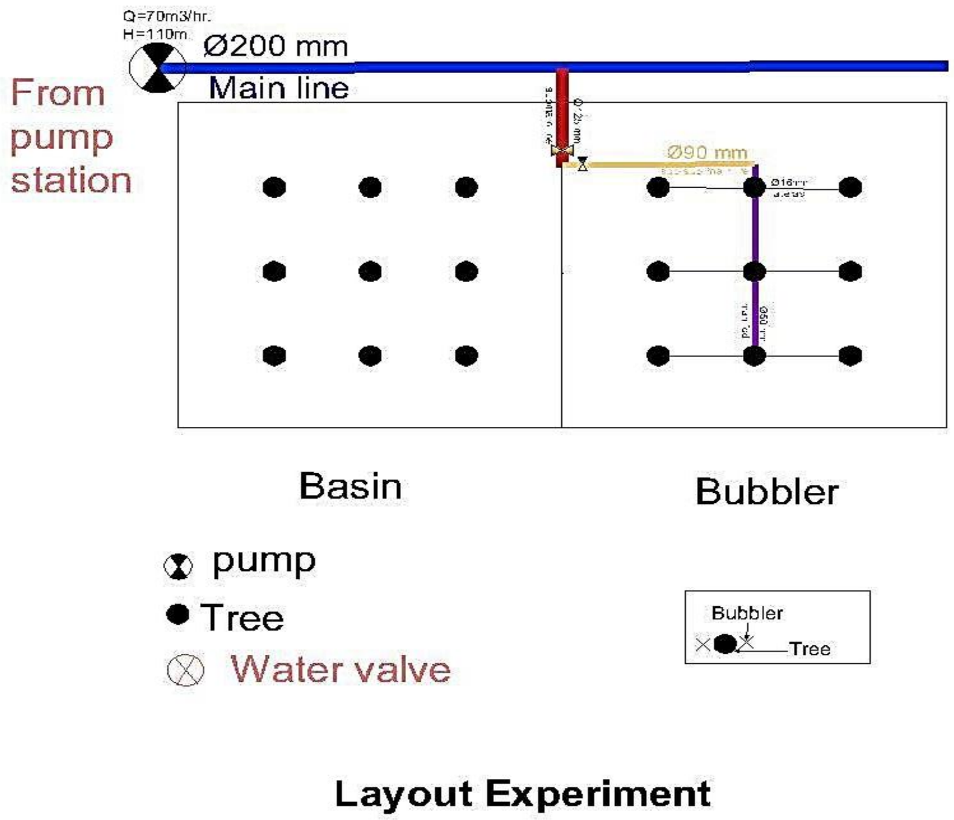

Table 3. Date palm crop coefficient during months of the year

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Crop coefficient	0.77	0.82	0.85	0.89	0.91	0.90	0.90	0.87	0.83	0.80	0.76	0.74

2-1-5 Climate data

Table 4. Reference climate data at Dakhla Source (Central laboratory for agriculture climate, 2014-2015)

Date	Temperature		RH (%)	WS (m/s)	ETo (mm)
	Min.	Max.	Aver.		Avg.
January	2.0	26.2	48	8.3	2.0
February	3.9	29.5	41	8.2	2.2
March	5.1	40.5	35	8.1	3.9
April	7.0	40.0	25	8.6	5.3
May	13.2	46.6	23	10.5	6.5
June	16.9	42.4	25	8.7	6.5
July	18.0	43.2	23	7.4	6.4
August	19.5	46.1	27	5.8	6.3
September	18.2	42.1	27	6.4	5.3
October	11.0	37.9	40	5.3	3.9
November	8.5	29.6	51	6.2	2.6
December	3.7	23.4	57	8.8	2.2

Tmp.Min= Minimum temperature in ◦C;
Prc= Precipitation in mm/d; **Tmp. Max=** Maximum temperature in ◦C;
WS=Wind speed at 2 meter above the surface in m/s and **Eto** = Referance evapotranspiration in mm/d **(FAO 2001)**

2-2- Methods

2-2-1- Irrigation requirement

1- Calculation evapotranspiration

Was calculated by penman-Monteith: Reference **Table (4)**

2- Selection of crop coefficient for estimating ETcrop:

ETcrop = ETo * Kc ………………………. (2-1)

Where:

ETcrop= Crop evapotranspiration in mm/day
ETo = Reference evapotranspiration in mm/day
Kc= Crop coefficient

3- Calculation of irrigation requirements

According to the following formula **(Abrol et al 1998)**

$$IR = \frac{ET_{crop}(LR+1)A}{Eu} \text{………………………..(2-2)}$$

$$\mathbf{IR_{Actual} = Qb\ x\ Nb\ x\ T\ x\ I\ x\ Ni} \text{……………….(2-3)}$$

$$\mathbf{IR_{Actual} = Qp\ x\ \ T\ x\ I\ x\ Ni} \text{…………………….(2-4)}$$

Where:

IR= Irrigation requirement, L/day;
LR= Leaching requirement, (20%);
A = Area of tree (m2)
Qb= Flow of bubbler (L/h)
Nb = Number of bubbler
T= Time of irrigation (hrs)
I= Irrigation time intervals
Ni= Number of intervals
Qp= Charge of pump (m^3/h)

2-2-2- Estimating field Emission uniformity (F.EU) according to Keller and Karameti, 1975

$$F.EU = \left[\frac{Q_n}{Q_a}\right] x\ 100 \text{…………………..(2-5)}$$

Where:

F.EU = Field test emission uniformity (%),
On = Average of the lowest (one fourth) of the emitters flow rate (L/h),
Qa = Average of the all emitters flow rate (L/h);

2-2-3- Estimating coefficient variation

The coefficient of variation (CV) is defined as the ratio of standard deviations of the discharges **(Madramootto, 1988).** In the lateral design, emitter flow variation is used as a design criterion. The emitter flow variation comprises hydraulic variation and due to manufacturing variation among the emitters. The latter depends on the quality control in production. The unit to unit variation in the emitter flow was expressed by the following relationship:

$$CV = Sd / q \quad \text{(2-6)}$$

Where:

CV = Manufacturing coefficient of variation
Sd = sample standard deviation
q average= Average emission rate of sample

Table 5. Classification manufacture's coefficient of variations

Emitter type	Cv range	Classification
Point source	<0.05	Excellent
	0.05-0.07	Average
	0.07-0.11	Marginal
	0.11-0.15	Poor
	>0.01	Unacceptable

Adopted from ASABE Standards EP405.1, 2008R

3. Results and Discussion

3.1. Calibration of bubbler and manufacturing coefficient of variation

3.1.1. Calibration of Bubbler

Fig. (2) shows hydraulic characteristics of selected bubbler types, it clear that by increasing operating pressure from 0.5 to 2.0 bar discharge were increased from 35.5 to 70 l/h for bubbler A, 33.7 to 62.2 l/h for bubbler B, and from 19.2 to 50 l/h for bubbler C.

Table 6. Calibration of bubbler

Pressure (Bar)	Flow (L/h)		
	Bubbler A	Bubbler B	Bubbler C
0.5	35.5	33.7	19.2
1	46.4	44.1	33.9
1.5	62.0	57.8	46.5
2	70.0	62.2	50.5

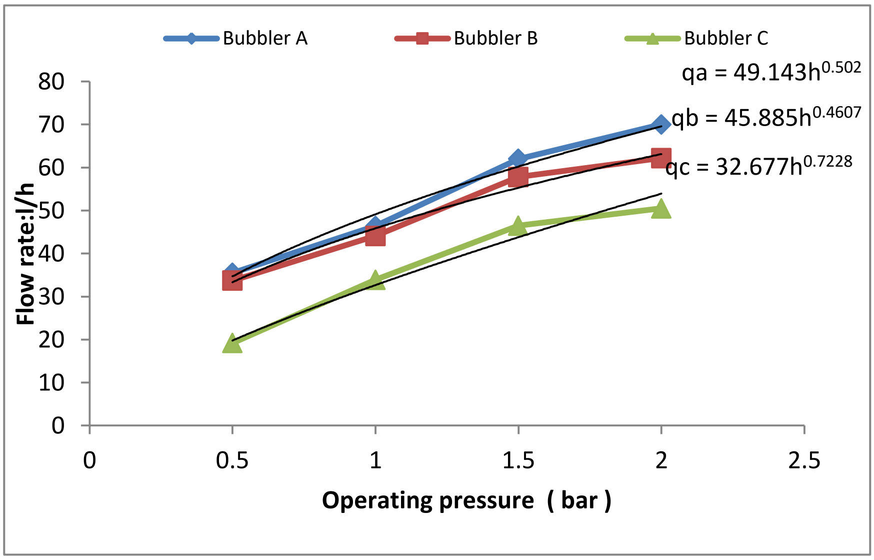

Fig. 2. Calibration of bubbler

3.1.2. Manufacturing coefficient of variation (C.V)

Tables (7 and 8) show the coefficient of variation for selected bubbler A was 0.04 and 0.06 at operating pressure of 1.0 and 1.5 bar. according to **Table (5)**. According to the best coefficient of variation bubbler A was selected for field tests.

3.2. Field distribution uniformity

As shown in **Table (9)** the distribution uniformity increased from 89 % to 94.5 % by increasing the pressure from 1 bar to 1.5 bar respectively. The best distribution uniformity was 94.5% for bubbler (A) under 1.5 bar pressure this will be a special experience operating pressure.

Table 7. Elements of cv. Equation (2.4) at pressure

Bubblers	Operating Pressure	Q average L/h	Sd	CV	Classification
A	0.5 bar	34.6	2.27	0.06	Average
	1 bar	45.1	3.5	0.07	Average
	1.5 bar	61.0	2.4	0.04	Excellent
	2 bar	70.0	4.1	0.06	Average
B	0.5 bar	37.2	3.4	0.09	Marginal
	1 bar	45.5	4.09	0.08	Marginal
	1.5 bar	56.2	3.9	0.07	Average
	2 bar	63.0	5.0	0.08	Marginal
C	0.5 bar	20.6	2.6	0.13	Poor
	1 bar	31.9	3.9	0.12	Poor
	1.5 bar	41.0	3.4	0.07	Average
	2 bar	53.0	5.9	0.11	Poor

Table 8. The value of c.v. under three bubblers

Pressure	C.V		
	Bubbler A	Bubbler B	Bubbler C
0.5	0.07	0.09	0.13
1	0.06	0.09	0.12
1.5	0.04	0.07	0.07
2	0.06	0.08	0.11

Table 9. Measured field distribution uniformity

Pressure	1	1.5
Distribution uniformity	89	94.5

3.3. Irrigation water requirements for palm trees under studied area conditions

At four age for date palm (*Phoenix dactylifera*), it was found that irrigation requirement for each one feddan equal 5739 m^3/feddan/year **(Table 10)** by used equation (2-1).

a- Actual irrigation requirement of date palm under basin irrigation system

It was found that actual amount water for each this is 146 m^3/palm/year and for one fadan equal 9660 m^3/fed/year as shown in **Table (10)** by used equation (2-4).

b. Actual irrigation requirement of date palm under bubbler irrigation system:

It was found that actual amount water for each this is 72m^3/palm/year and for one fadan equal 4752 m^3/fed/year as shown in **Table (10)** by used equation (2-3).

Table 10. Irrigation requirement for the palm trees

Month	ETo	Kc	ETorp	Water requirement		Actual irrigation requirement			
						Basin		Bubbler	
				mm/ month	m^3/fed/ month	mm/ month	m^3/fed/ month	mm/ month	m^3/fed/ month
Jan	2.0	0.77	1.4	46.2	194	150	630	75.4	316.8
Feb	2.7	0.82	2.2	66.4	279	150	630	75.4	316.8
May	3.9	0.85	3.3	99	416	150	630	75.4	316.8
Apr	5.3	0.89	4.7	141	592	200	840	94.2	396.0
May	6.5	0.91	5.9	177	743	200	840	94.2	396.0
June	6.5	0.9	5.9	177	743	250	1050	113	475.2
July	6.4	0.9	5.7	171	718	250	1050	113	475.2
Aug	6.3	0.87	5.4	162	680	250	1050	113	475.2
Sep	5.3	0.83	4.3	129	542	250	1050	113	475.2
Oct	3.9	0.8	3.1	93	391	150	630	94.2	396.0
Nov	2.6	0.76	1.9	57	239	150	630	94.2	396.0
Des	2.2	0.74	1.6	48	202	150	630	94.2	316.8
					5739		9660		4752
					m^3/fed./ year		m^3/fed./ year		m^3/fed./ year

Fig. (3) shows the average irrigation requirements of date palm for two season were (9660-4752) m^3/fed./year for (basin & bubbler) irrigation systems, the water saving of 50% was obtained by using selected bubbler compared with basin irrigation system.

3.3. Vegetative Properties of date palm

Fig. (4, 5, 6, 7, 8 and 9) illustrate that measured vegetative properties of date palm by using imported bubbler A compared with basin system. It's clear that using selected imported bubbler recorded higher vegetative properties compared with basin irrigation system.

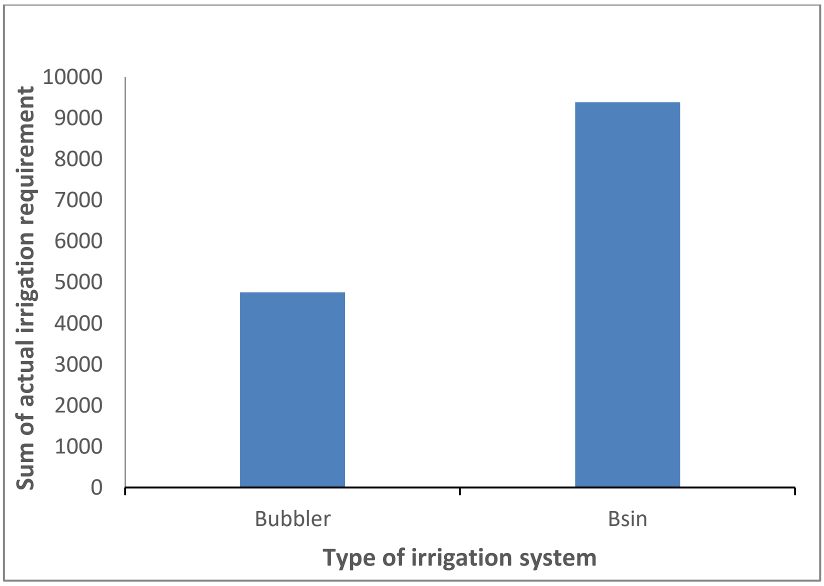

Fig. 3. Comparison between the actual irrigation requirement of date palm under basin & bubber irrigation system

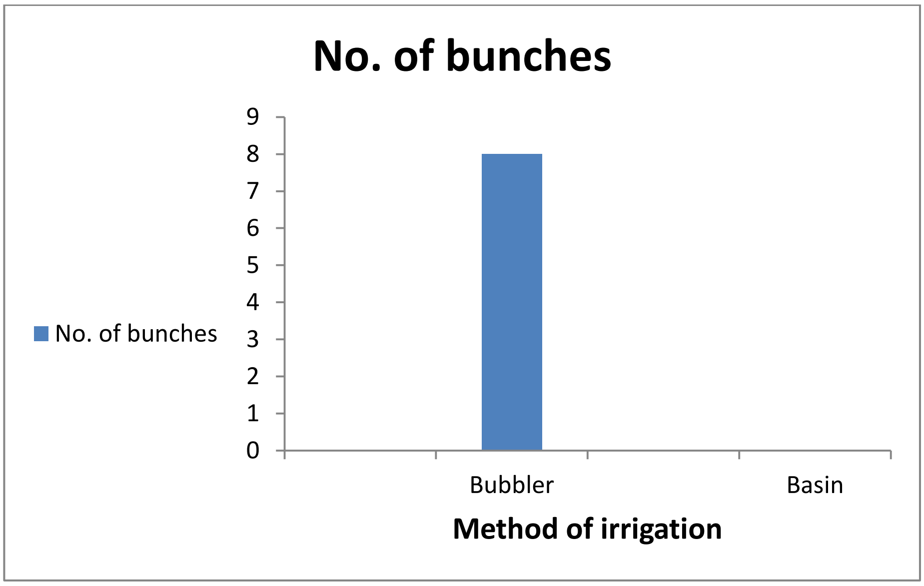

Fig. 4. Effect of irrigation system on No. of bunches

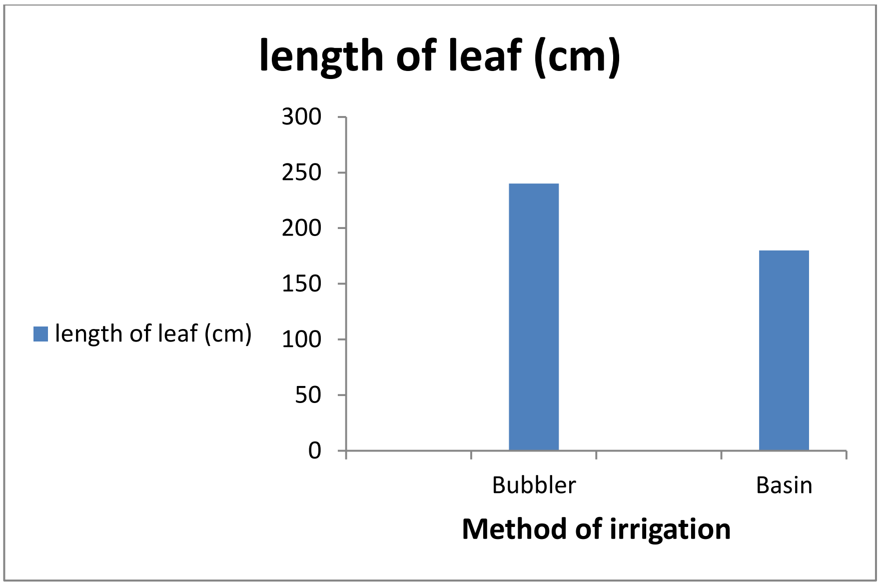

Fig. 5. Effect of irrigation system on length of leaf (cm)

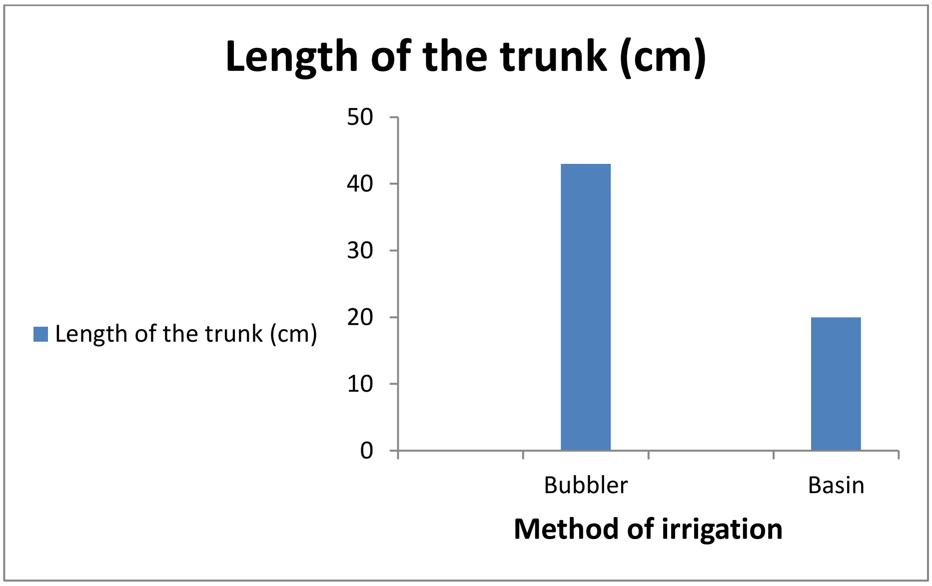

Fig. 6. Effect of irrigation system on length of the trunk (cm)

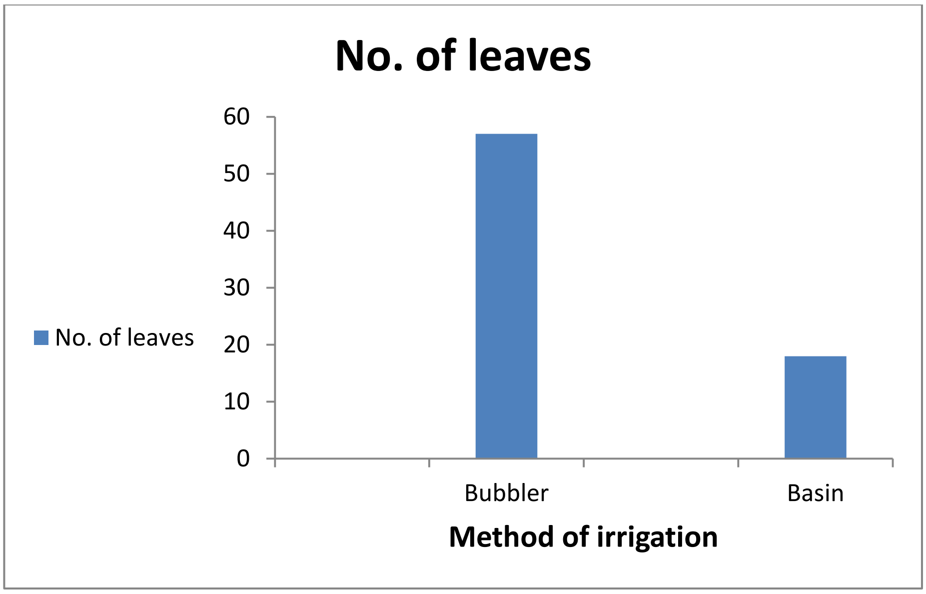

Fig. 7. Effect of irrigation system on No. of leaves

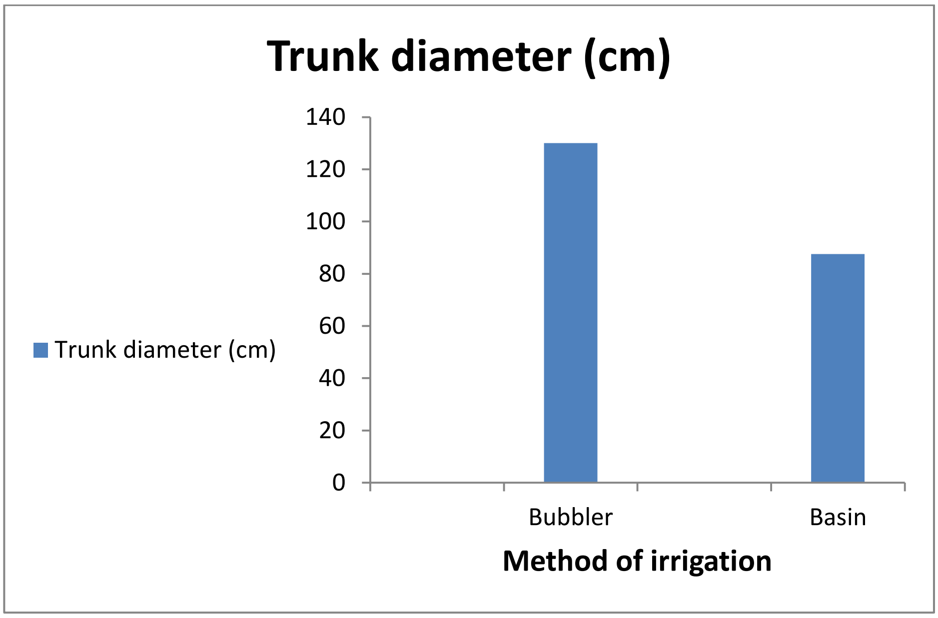

Fig. 8. Effect of irrigation system on Trunk diameter (cm)

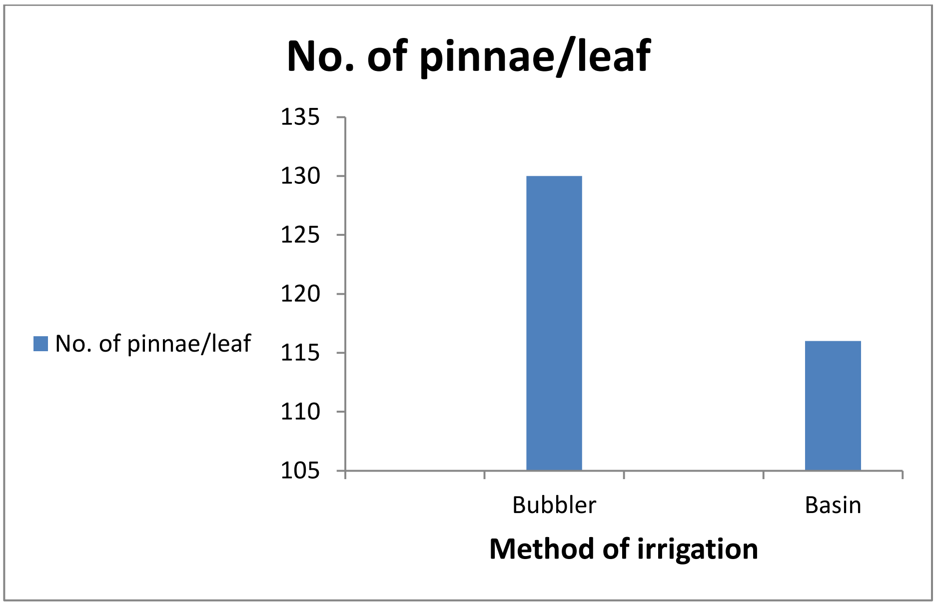

Fig. 9. Effect of irrigation system on No. of pinnae/leaf

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