MANEGMENT OF BUBBLER IRRIGATION SYSTEM.

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ABSTRACT

This Research aims to obtain an appropriate management for bubbler-irrigation system in order to overcome the problem of its field emission uniformity is low.

The Experiment was carried out at the experimental farm of the Faculty of Agriculture, Ain shams University, at Shalaquan village, Kalubia, Governrate, on (70% canopy) for Citrus crop as the total area of tree equal 25 m^2.

Bubbler characteristic by hoses are anchored to a tree or stake, and hose heights are adjusted so that water flows out from all delivery hoses at about equal rates. Two heads of water in the tank (water source) 120 and 160 cm were examined then we found the results as follow:

1- *Field emission uniformity (F.Eu)*
   - a- *At lateral length 45m field emission uniformity 42% and 68% at water height in the tank 120 cm and 160cm respectively*
   - b- *It is found that maximum lateral line length for acceptable uniformity 89% is 30m.*

2- *Irrigation requirement is 2868 m^3/fed/yr*

3- *And water use efficiency equals 84 kg/m^3/ fed*

1. INTRODUCTION

The first gravity- flow bubbler system was probably introduced by **Rawlins, 1977,** who developed the system at the U.S. Department of Agriculture, salinity Laboratory in river side. **Yitayew et al. (1994)** showed that the name of the system bubbler was derived when the system operated from the fountain of water streaming out the hoses, and from the bubbling noise made as air escapes from the pipe lines.

In this research we study and review an irrigation system which reduces the cost and water consumption.

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This system is Bubbler irrigation system which despite its simplicity and its many advantages it's the most difficult irrigation system in designing.

Bubblers typically apply water on a "per plant" basis. Bubblers are very similar to the point source external emitters in shape but differ in performance. Water from the bubbler head either runs down from the emission device or spreads a few inches in an umbrella pattern. The bubbler emitters dissipate water pressure through a variety of diaphragm materials and deflect water through small orifices. Most bubbler em itters are marketed as pressure compensating.

The bubbler emission devices are equipped with single or multiple port outlets. Most bubbler heads are used in planter boxes, tree wells, or specialized landscape applications where deep localized watering is preferable. The typical flow rate from bubbler emitters is between 2 and 20 gph **(Aung K. H. and F. T. Schere, 2003)** Bubbler irrigation is primarily suited for permanent wide-spacing crops such as orchards and vineyards **(Behoteguy and Thronton, 1980).**

Running of water in bubbler irrigation system depends on the effect of pressure caused by rising water column in the reservoir and the gravity by making a gradual slope in the land **Yitayew et al. (1994)**

Hull.1981 mentioned that it's important to use low-head Bubbler irrigation system as it gives higher flow rate and larger diameter of pipe used, resulting in fewer blockages, compared with trickle systems.

- Elaborate filtration equipment is unnecessary and the associated head loss resulting in increased pumping cost therefore it is eliminated.
- Quality of the water is not critical.
- Operate at low heads associated with lighter system components.
- Relatively low overall cost compared with other solid set system. Despite this bubbler irrigation has not widely been used, because of the following reasons:
- Lack of well defined design procedure.
- Lack of manufactured watertight fittings,
- And also intricate installation.

Localized irrigation system is considered as the most system which decreases water consumption and it is the most frequently used in old lands in delta especially for fruit crops. The objective of this study is to identify the effective factors on management and choose a suitable head of water in the tank which gives acceptable field emission uniformity within the surrounding condition which is related to the soil and the climate, to study the effect of length of water head in the tank on discharge of hoses, estimating irrigation requirement and interval, measuring evapotranspiration, Identify the important measurements which are related to the soil and climatic conditions and to get the maximum lateral line length with the best uniformity distribution.

In this study, two groups of experiments were carried out as follow

(1) Laboratory experiments carried out on chosen outlets to determine an appropriate outlet with bubbler irrigation system,

(2) Field experiments carried out on the optimum outlet selected from laboratory experiments, to obtain the maximum lateral-line length with the best uniformity distribution.

II.MATERIALS AND METHODS

2-1 Materials.

2-1-1 Location

Experiments were carried out at the Experimental Farm of the Faculty of Agriculture, Ain Shams University, at Shalaquan village, Kalubia Governorate.

Soil and irrigation water analysis were conducted according to standard procedures and represented in Tables (1, 2 and 3).

Table (1): Some physical properties of Shalaqan site.

Soil depth, cm	Particle size Distribution, %				F.C. %	W.P. %	B.D. g/cm^3	Texture class
	coarse Sand	fine Sand	Silt	Clay				
0-30	3	34.2	22.2	40.6	28	16	1.25	Clay
30-60	4.2	31.6	22.3	41.9	31	18	1.43	Clay
60-100	4.3	30.2	26.1	39.4	27	18	1.43	Clay loam

Table (2) : Some chemical properties of Shalaqan site.

Soil depth, cm	PH 1:2.5	ECe dS/m	Soluble Cations, meq/L				Soluble Anions, meq/L			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	SO_4^{--}	CL^{-}
0-30	7.8	4.53	23.2	12.0	7.7	2.4	-	0.9	27.5	16.7
30-60	8.3	2.0	10.4	6.1	1.3	2.3	-	1.5	13.4	5.1
60-100	8.3	1.75	8.1	6.0	1.0	2.4	-	1.7	12.6	3.2

Table (3): Some chemical data of irrigation water at Shalaqan site.

pH	EC dS/m	Soluble Cations, meq/L				Soluble Anions, meq/L			SAR
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	SO_4^{--}	CL^{-}	
8.2	0.82	1.7	0.84	4.77	0.88	2.38	0.14	5.68	4.23

2-1-2 Irrigation Systems:

The low head bubbler irrigation system consisted of a mainline connected to a water source, a constant head device, manifolds, laterals, and small-diameter delivery hoses, as shown in figure 2. The Lateral are laid midway between two rows of trees, and small diameter delivery hoses (Called delivery hoses or tubes) are inserted in the laterals to deliver water to the trees. Hoses are anchored to a tree or stake, and the hose heights are adjusted so that water flows out from all delivery hoses at equal rates.

- **Main line:** (110 mm outer diameter, PVC and 46 m Length)
- **Manifolds:** (50 mm outer diameter, 90 m long)
- **Laterals:** (32 mm outer diameter,45 m long)
- **Hoses:** (16 mm outer diameter, hoses elevations mentioned in table (4) and fig. (1))

2-1-3 Hose elevations

Table (4): Hose elevation under each tree for the first, the middle and the last line.

Lateral length, m	First line	Middle line	Last line
5	50 cm	40 cm	27 cm
10	46 cm	27 cm	24 cm
15	40 cm	25 cm	23 cm
20	35 cm	23 cm	20 cm
25	30 cm	21 cm	15 cm
30	24 cm	19 cm	12 cm
35	20 cm	15 cm	5 cm
40	15 cm	12 cm	3 cm
45	12 cm	10 cm	1 cm

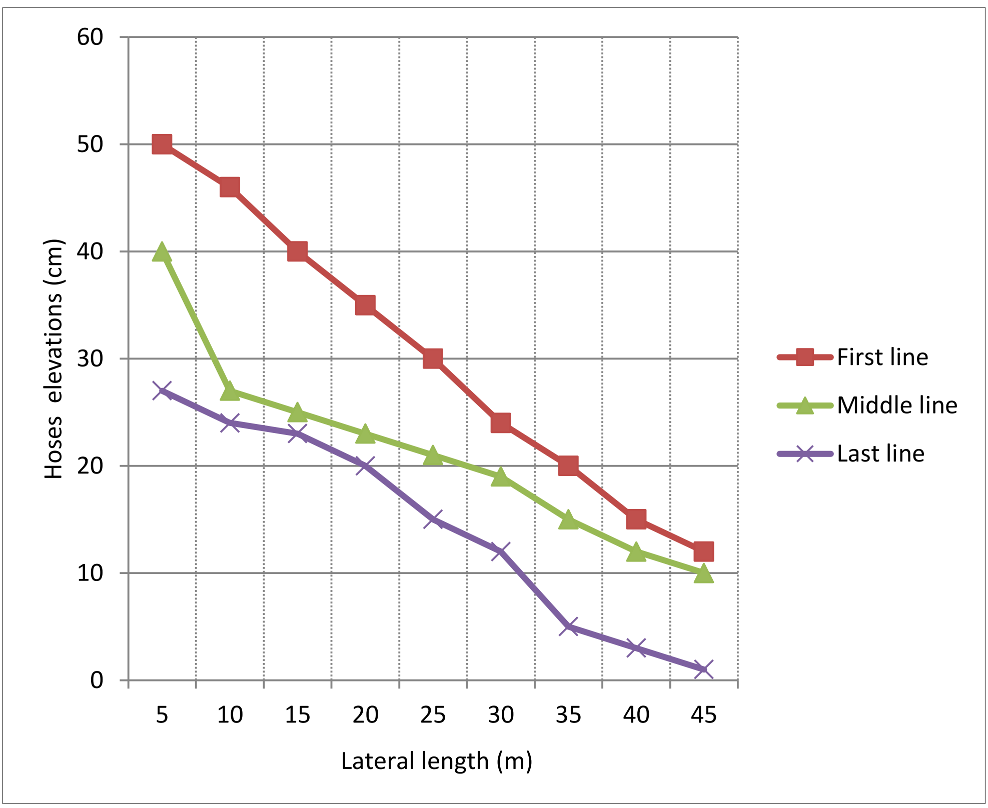
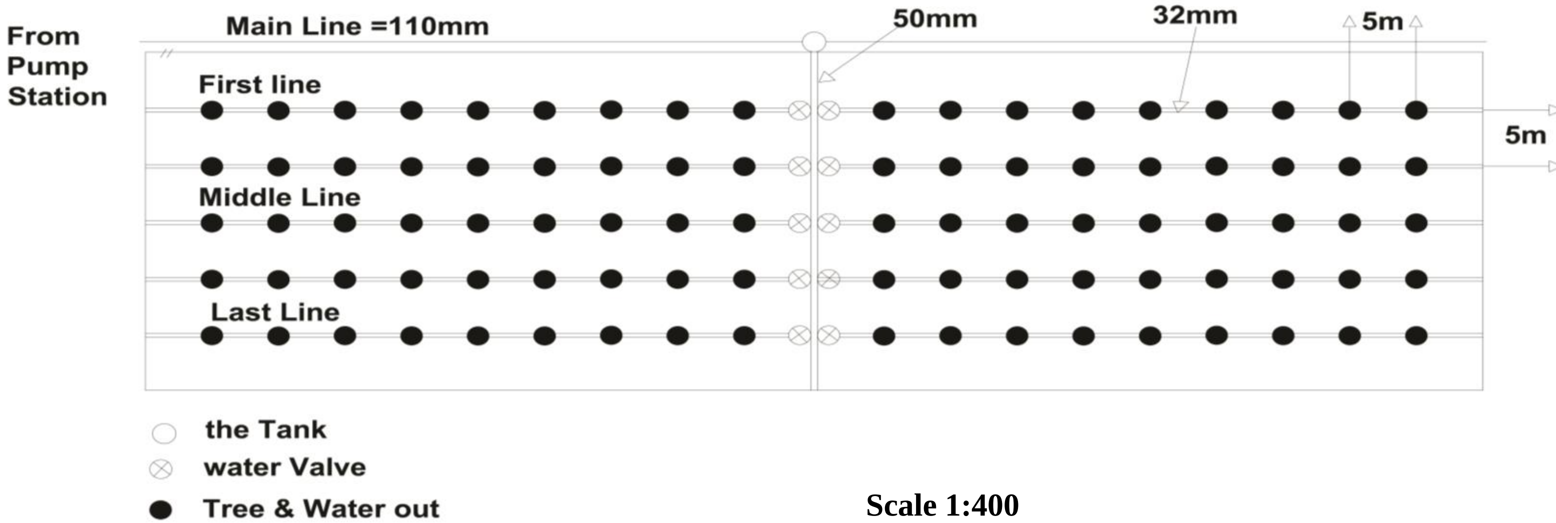


Fig (1): Bubbler Hoses heights along lateral line.



Scale 1:400

Fig (2): layout of shalaquan site

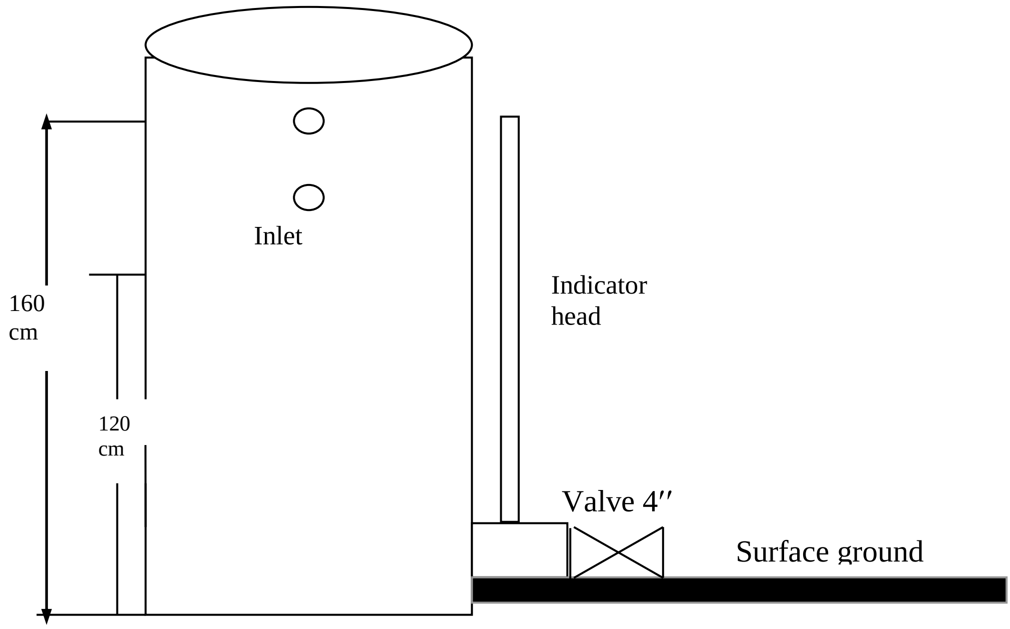


Fig (3): Tank for calibration Bubbler.

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2-1-4 Crop and climate

Citrus crop total area of tree equals 25 m^2. Citrus crop coefficient (70% canopy) and root depth (1- 1.2 m) **(Wright, 2000)** are shown in table (5)

Table (5): Citrus crop coefficient and months in the year.

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
0.50	0.50	0.80	0.80	0.80	0.85	1.00	1.00	1.00	0.85	0.50	0.50

Table (6): Reference Evapotranspiration data at Shalaquan.

Month	Prc. mm/d	Tmp. Max °C	Tmp. Min °C	Sun shine %	Wind speed (2m) m/s	Eto mm/d
Jan	1.6	18.8	8.3	61.4	2.8	2.2
Feb	0.8	18.8	9.7	66.6	2.9	2.7
Mar	0.4	21.3	10.3	87.	3.0	3.5
Apr	0.4	23.3	13.2	71.73	2.8	4.5
May	0.1	28.1	15.9	75.4	2.7	5.4
Jun	0.0	38.5	19.5	83.8	2.5	6.6
Jul	0.0	31.3	21.7	83.3	2.5	6.6
Aug	0.0	31.4	21.9	84.7	2.3	5.6
Sep	0.0	38.5	20.1	60.0	2.2	4.8
Oct	0.3	28.2	17.1	79.3	2.2	3.8
Nov	0.8	24.1	13.4	71.1	2.2	2.7
Dec	1.4	20.3	9.6	63.5	2.5	2.2

Tmp.Min= Minimum temperature in °C;
Prc= Precipitation in mm/d; **Tmp. Max=** Maximum temperature in °C; Sun shine fraction in percentage; 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 Estimating Discharge of hoses:

Measured in the field (fig_s 4 and 5)

2-2-2 Estimating of irrigation requirement and intervals:

1- **Estimating evapotranspiration**

Was calculated by Penman-Monteith: Reference table (6)

2- Selection of crop coefficient for estimating ET crop:

$$ET_{crop} = ET_o \times Kc \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where:

Kc = Crop coefficient, (%) shown in table (5)

3- Estimating of irrigation requirements

From the following equation:

$$IR = \frac{ET_{crop} \times (LR+1) \times A}{Ea} \ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$ **(Abrol et al.1988)**

Where:

IR = irrigation requirement, L/day

LR = Leaching requirement, (20%)

Ea = Irrigation uniformity (68%) (Measured in the field)

A= Area of tree (m^2)

2-2-3 Measurements and Calculations of crops:

a- Yield and yield attributes:

At the harvest date, we took the production of three trees in each line the first, the last and one in between that's for the first and the third and the fifth line then the following data were measured:

1- Fruit weight (kg/tree)

b- Water use efficiency (WUE):

Was calculated according to **Israelsen and Hansen (1962)** as follows:

$$WUE = Y / W \ldots\ldots\ldots\ldots\ldots(3)$$

Where:

WUE = Water use efficiency, kg-yield / m^3 water.

Y = Total yield, kg; and

W= Total applied irrigation water, m^3

2-2-4 Estimating field Emission uniformity (F.EU)

The discharge rates of the bubbler were measured for 45 hoses which were randomly selected. Thereafter, the following two emission uniformity equations **(Keller and Karameli, 1975)** were used.

$$F.EU = [Q_n / Q_a] \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

$$F.EU_a = \frac{1}{2}\left[(Q_n/Q_a) + (Q_a/Q_x)\right] \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Where:

F.EU = Field test emission uniformity (%),

$F.EU_a$ = Field test emission uniformity absolutely (%),

O_n =Average of the lowest (one fourth) of the emitters flow rate (L/h).

Q_a = Average of the all emitters flow rate (L/h); and

Q_x = Average of the highest (one eighth) of the emitters flow rate (L/h).

2-2-5 Estimating of head loss along lateral line

The Darcy-Weisbach and Blasius equations can be combined to predict friction head loss, hf (m), accurately in bubbler tubes ***(Keller and Bliesner, 1990)***

$$h_f = K_{fdw} \frac{Q^{1.852}}{D^{4.871}} L \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6)$$

Where:

hf = Friction head loss in Laterals, m

K_{fdw} = 15.27 constant for SI units at a water temperature of 20°C.

Q= Flow within Lateral, l/s

D= Inside diameter, cm

L= Length of Lateral line, m

2-2-6 Expermintal layout and parameters

1- Head of water in the tank
2 heads (120 and 160cm)

2- Irrigation Requirement and management
Eto method and applied water requirement

3- Design of method
(Applied design in location sites)

IV- RESULTS AND DISCUSSION

3-1-1 Estimating field Emission uniformity (F.EU) for bubbler

For bubbler Field emission uniformity at water head in the tank 160 cm is higher than that at head 120 cm as shown in figs (4 and 5). It's found that field emission uniformity was affected by discharge of hoses which was affected by length of hose and its closeness or nearness from water source, as shown in fig (4) the field Emission uniformity at head of tank 120 cm is not acceptable at all lateral lengths as it is equal 42% (at lateral line length 45 m) also by cancelling the ninth tree in each line (at lateral line length 40 m) it will be 42.5%, then by cancelling the ninth and the eights tree in each line (at lateral line length 35 m) the uniformity will be 45% and by cancelling the ninth, the eighth and the seventh tree in each line (at lateral line length 30 m) the uniformity will be 48%.

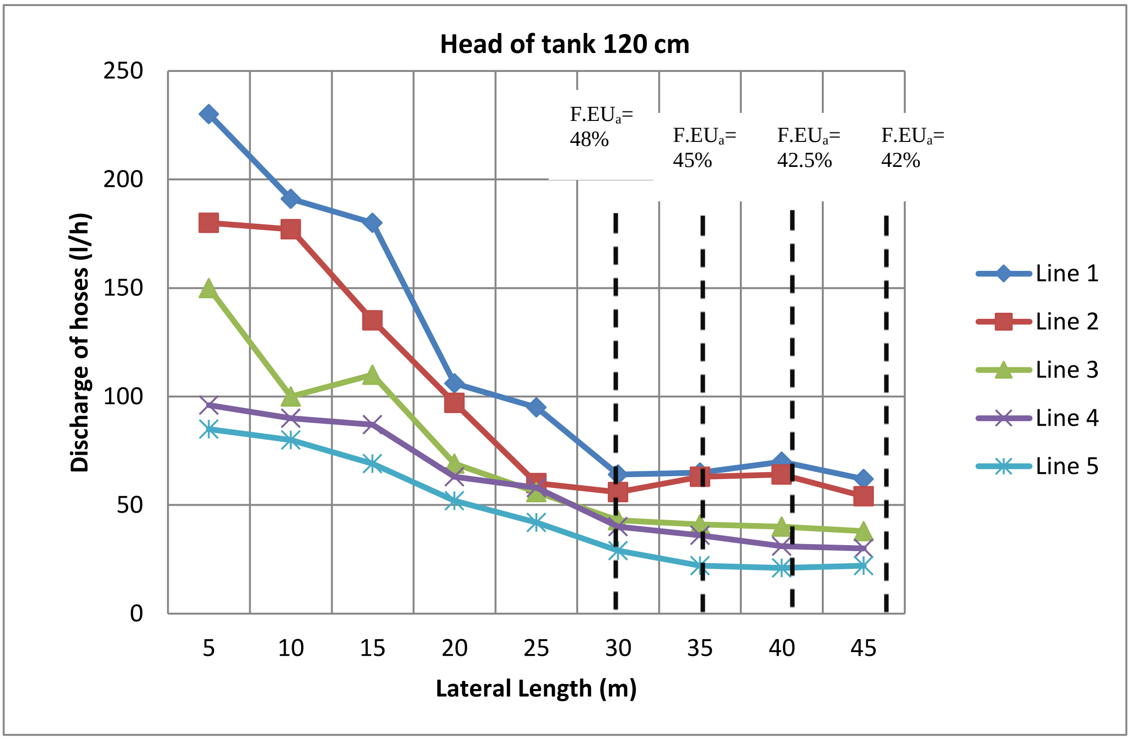

Fig (4) Discharge of hoses along the lateral line at 120 cm water head.

<u>3-1-2 Emission uniformity at different lateral line length.</u>

For acceptable uniformity (89%) it's recommended that maximum lateral line length is 30 m and that illustrated in Fig (5). Emission uniformity increase by cancelling the ninth tree in each line (at lateral line length 40 m) it will be 75.6%, then by cancelling the ninth and the eights tree in each line (at lateral line length 35 m) the uniformity will be 82.6% and by cancelling the ninth, the eighth and the seventh tree in each line (at lateral line length 30 m) the uniformity will be 89%.

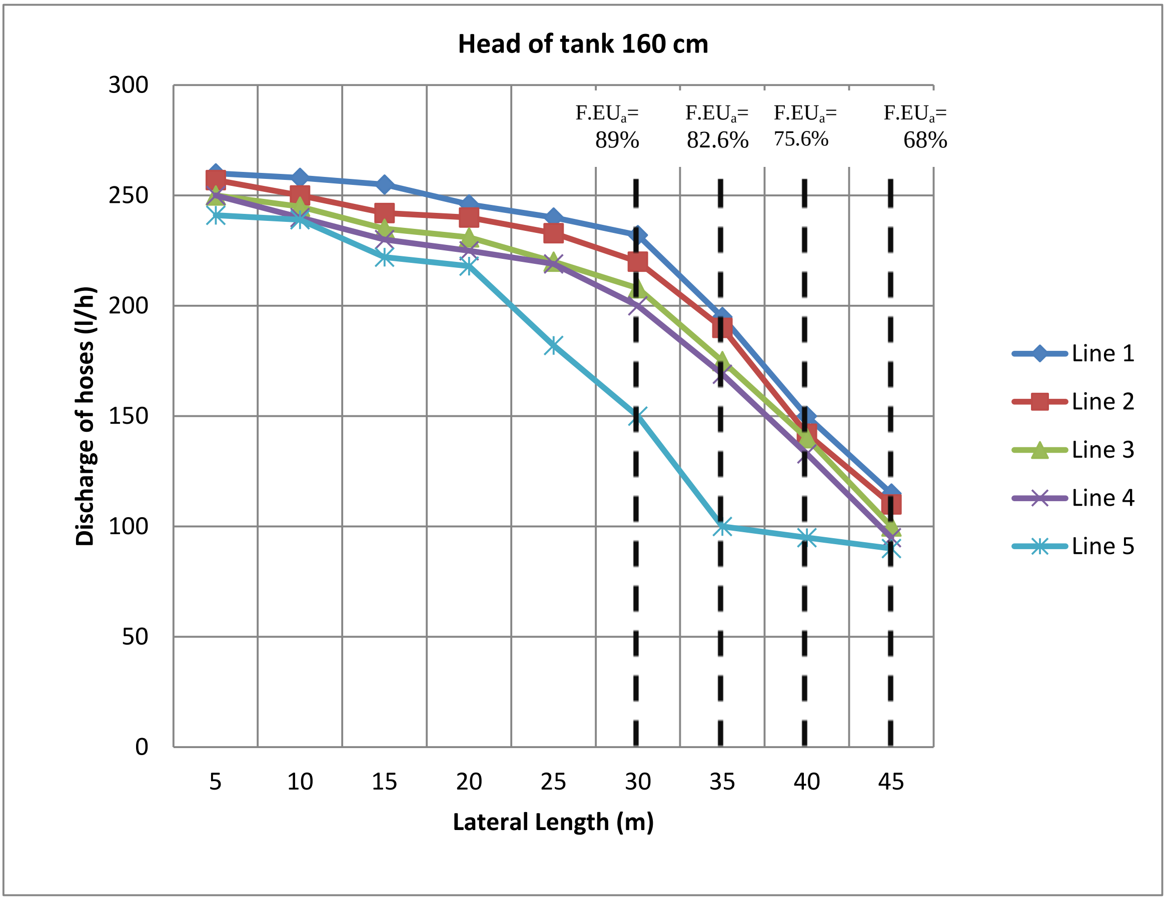

Fig (5): Discharge of bubbler hoses along the lateral line and emission uniformity at different lateral lengths.

3-2 Irrigation Requirements Practical and theoretical

a- Theoretical

At 70% Canopy for citruss crop by calculations, it was found that irrigation requirment for each tree is 39092 lit/tree/year and for one faddan equal 6567.5 m^3/Feddan/year as shown in table (7). Also **El-Shazly 1999** mentioned that the irrigation requirement for citrus crop 50% canopy equals to 3632 m^3/ fed/year and that is similar to the experiment results.

Table (7) irrigation requirment for the tree theortical

Month	IR Lit/day/tree	Liter/ tree/month
Junury	34	1053
Februry	41.7	1167.4
March	86.47	2680.6
April	111.18	3335.3
May	133.41	4135.8
June	173.25	5197.5
July	203.82	6318.5
August	172.94	5361.2
September	148.24	4447.1
October	99.75	3092.2
November	41.7	1250.7
December	34	1053.1
Sum		39092 Lit/yr
		6567.5 m^3/fed/yr

<u>b- Practice</u>

The average of discharges of hoses (at height 160 cm) as estimated practically from the experiment is 198.5. After calculations the summation of irrigation requirement for each tree on the year practically was 17071 lit/tree/year and for one feddan was 2868 m^3/Fed/yr. (table 8) and (Figure 6)

Table (8) irrigation requirment for the tree practical

Month	Average irrigation requirment for tree Lit/h	No of hours/ month	Liter/ month
Junuary	198.5	0	0
Feb(1-15)	198.5	0	0
Feb(15-30)	198.5	4	794
March	198.5	8	1588
April	198.5	8	1588
May	198.5	8	1588
June	198.5	12	2382
July	198.5	12	2382
Aug	198.5	12	2382
September	198.5	8	1588
October	198.5	8	1588
November	198.5	4	794
December	198.5	2	397
Sum			**17071Lit/yr**
2868 m^3/Fed/yr			

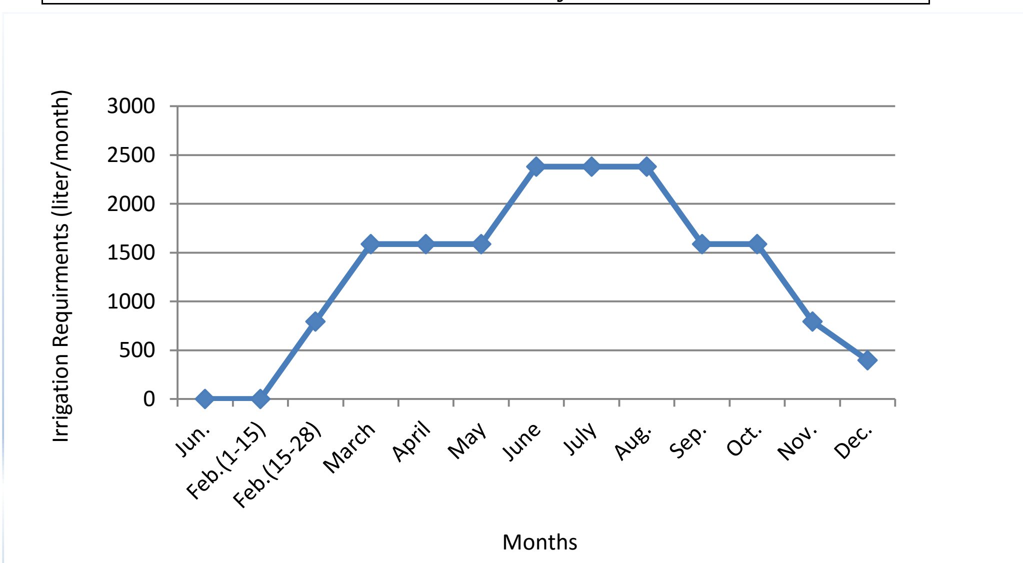

Fig (6): Irrigation Requirements along months of 2010 year.

3-3 Head loss along lateral line

Figs (7, 8) Show the decreasing in hoses elevations (cm) along the first lateral line at head of tank (160cm, 120cm) respectively as the Discharge of hoses (l/s) decrease and that is effect on head loss (cm) along the lateral line.

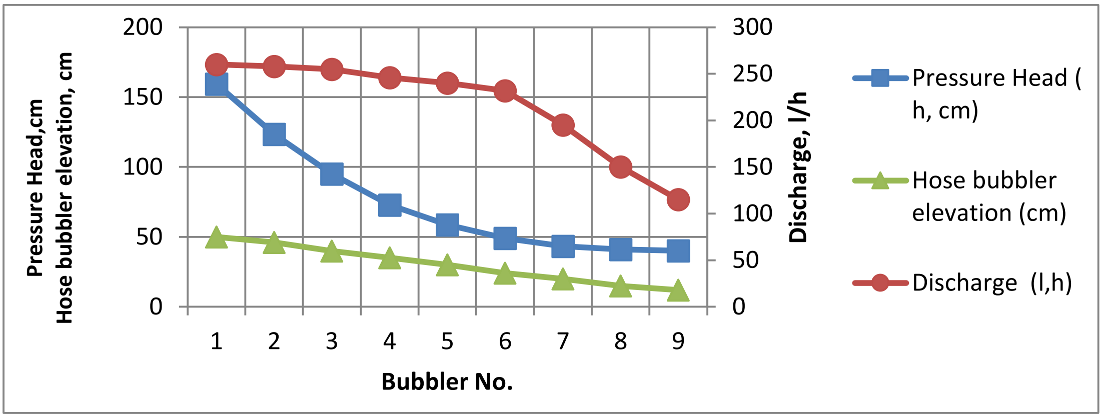

Fig (7): Pressure Head, Discharge of hoses and Hoses bubbler elevations along the first Lateral line for head of tank 160 cm

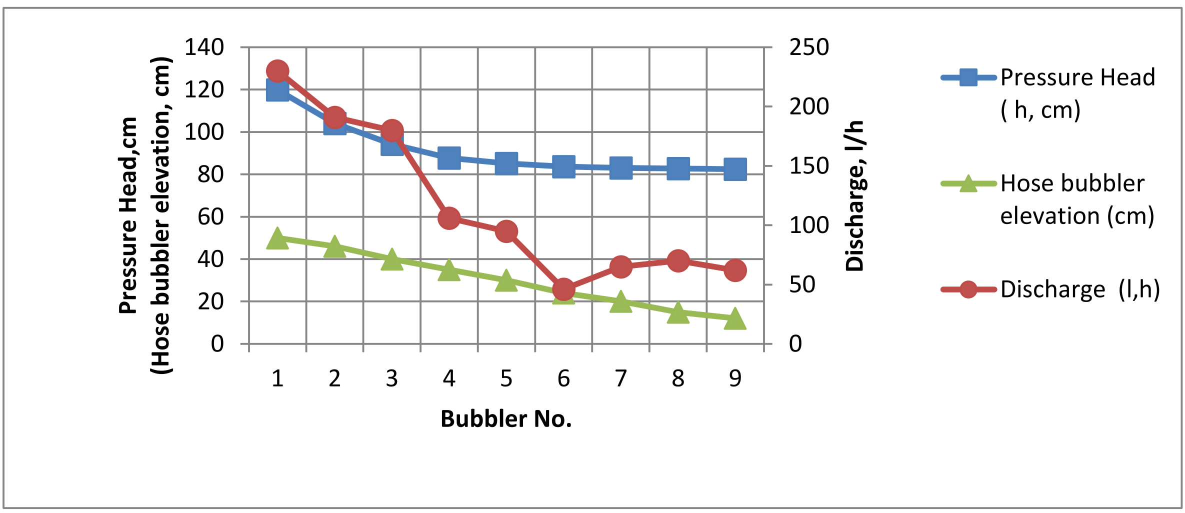

Fig (8): Pressure Head, Discharge of hoses and Hoses bubbler elevations along the first Lateral line for head of tank 120 cm

3-4 Water use Efficiency for bubbler

As shown in table (9) production of tree increases by increasing irrigation requirement and so water use efficiency increases. After calculations we found that the average of water use efficiency was 0.5 so water use efficiency for one feddan was (0.5x168)= 84 kg/m^3/ fed

Table (9) Production of tree, Irrigation requirment for the tree Practical and water use efficiency

No. of line	Average Fruit Wight (kg/tree)	IR m^3/tree/ year	Water use efficiency (kg-yield/m^3water)
Line (No.1)	10	17.63	0.5
Line (No.3)	9	16.34	0.5
Line (No.5)	8	14.7	0.5

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الملخص العربي

تصميم وإدارة نظام الرى الفوار "النافورى"

سالى أ. أمين* ، محمود م. حجازى و خالد فـ. الباجورى****

يهدف هذا البحث لإدارة نظام الرى النافورى بحيث يمكن التغلب على مشكلة قلة انتظاميه توزيعه للمياه داخل الحقل.

لقد أجريت التجربة على محصول الموالح داخل مزرعة كلية الزراعة جامعة عين شمس قرية شلقان محافظة القليوبية. يتميز النظام بخراطيم تسليم أو أنابيب يتم إدراجها في الخطوط الفرعية لتوصيل المياه إلى الأشجار ويتم تثبيت كل خرطوم فى الشجرة و تعديل ارتفاعات هذة الخراطيم بحيث يتم توصيل المياه لكل شجرة بتصرفات متساوية تقريبا .

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لقد أجريت التجربة بإختبار ارتفاعين من المياه داخل الخزان (مصدر المياه) وهم ١٢٠ و ١٦٠ سم وكانت النتائج كالتالى:

١-انتظامية التوزيع

أ- عند طول الخط الفرعى ٤٥ م بلغت اتظامية التوزيع ٤٢% و ٦٨% عند ضاغط ١٢٠سم و ١٦٠سم على التوالى

ب- بتمثيل النتائج للحصول على أعلى انتظامية توزيع متوقعة ٨٩% كان يجب أن يصل طول الخط الفرعى الى ٣٠ م

٢-بلغت الاحتياجات المائية لفدان الموالح فى السنة ٢٨٦٨ م^{٣}/فدان/سنة

٣- كفاءة استخدام المياه لفدان الموالح *يساوى* ٨٤ كجم/ م^{٣} /فدان .