

***A STUDY ON AN APPROPRIATE DESIGN  
FOR BUBBLER IRRIGATION SYSTEM***

***BY***

***AHMED MAHER EL LITHY***

B.Sc. (Ag. Mech.) Ain Shams University, 1991

*A thesis submitted in partial fulfillment  
of  
the requirements for the degree of*



***MASTER OF SCIENCE***

*in*

***AGRICULTURE***

***(AGRICULTURAL MECHANIZATION)***

*Department of Agricultural Mechanization  
Faculty of Agriculture  
Ain Shams University*

**1998**







## Approval Sheet

# A STUDY ON AN APPROPRIATE DESIGN FOR BUBBLER IRRIGATION SYSTEM

BY

***Ahmed Maher El-Lithy***

B.Sc.(Agric.Mech.) Ain Shams University, 1991

This thesis for M. Sc. degree has been approved by:

**Prof. Dr. A. I. Hashish** *A. Hashish* .....

Prof. and Head of Ag. Eng. Dep., Zagazig Univ.

**Prof. Dr. El-Tony M. A. El-Tony** *El-Tony M. A.* .....

Prof. of Soils, Ain Shams Univ.

**Prof. Dr. M. N. El-Awady** *M. N. El-Awady* .....

Prof. of Ag. Eng., Ain Shams Univ. (Supervisor)

Date of examination: 10 / 12 / 1997



## ACKNOWLEDGMENT

The author wishes to thank "**Allah**" for allowing him to the completion of this work.

He wishes to express his greatest appreciation and deepest gratitude to his Principal Supervisor: **Prof. Dr. Mohamed Nabil El Awady**, Prof Emerit. of Agricultural Engineering, Fac. of Agric., Ain Shams Univ., for suggesting this research, and also for kind guidance and encouragement.

He wishes also to express his deep gratitude to **Prof. Dr. Ahmed Farid El-Sahrigi** Prof. Ain Shams Univ. and consultant of Agricultural Engineering Research Institute (AEnRI), in addition to **Dr. Hassan A. Abdel Mawla** Head of Section; AEnRI, for their advices and continuous help to fulfill this work.

Special thanks are to be given to **Dr. Ibrahim Yehia El Sayed**, AEnRI, in addition to **Mr. Mohamed Tyssir El-Lithy**, **Mr. Haitham Nabih** and **Mr. Mohamed Nabih** for continuous help during laboratory and field tests.

Special thanks also to **Dr. Mohamed Montasser Ibrahim**, for his kind guidance and continuous encouragement.

Thanks to all who have helped, to complete this work.



## **ABSTRACT**

Ahmed Maher El-Lithy. A study on an appropriate design for bubbler irrigation system. Unpublished Master of Science, University of Ain Shams, Faculty of Agriculture, Department of Agricultural Mechanization, 1997.

The aims of this study is to get the greatest lateral line length with the best uniformity distribution, through extending it into multi stages with different emitter sizes on each stages.

The main results in this study are summarized in the following:

### **I- Laboratory experiments.**

#### **(1) The effect of pressure head and tube diameter on discharge.**

- The discharge of tube increased from "19.59" to " 74.35 L/h" by increasing pressure head from "0.025" to " 1 bar" at tube diameter of "3 mm". The discharge increased from "27.97" to " 54.07 L/h" by increasing tube -diameter from "3" to "4 mm" at pressure head of "0.25 bar".

#### **(2) The effect of pressure and diameter of nozzle on discharge.**

- The relationships between nozzle discharge (q) and pressure head (h) at different nozzle-diameters were conducted in the following equation:  $q = kh^x$  where k and x are constant.

#### **(3) The effect of pressure and type of screw emitter on discharge.**

- The discharge of screw emitter decreased by increasing number of screw thread teeth and screw length into tube at all pressure heads. And the discharge increased by increasing pressure heads.

#### **(4) The effect of valve-emitter angle on discharge.**

- It was noticed that there was a wide variation of discharge trying to adjust valves as emitters in field. Thus this part of experiment was cancelled.

### **II- Field experiments.**

- It was found that the lateral length (concerning pressure drop within 10 %) increased by increasing the nozzles spacings. The lateral lengths



were "120", "150" and "168 m" at nozzles spacings of "4", "5" and "6 m" respectively at pressure heads of "1 bar" and "1.4 bar".

**(5) Extending the maximum allowable lateral length through multistaging with wider emitters downstream.**

- It was noticed that the discharge distribution along lateral-line is similar to saw teeth that indicate a good discharge-variation within 5 % along the lateral-line. The lateral length was thus extended by a number of times corresponding to the number of stages.

**(6) The effect of nozzles spacing and pressure head on uniformity distribution.**

- The uniformity coefficients were "98.24", "98.69", and "98.36 %" at nozzles spacings of "4", "5", and "6 m" respectively and pressure head of "1 bar". These data indicated that there was no remarked effect of nozzles spacings on uniformity- distribution.
- It was found that the uniformity coefficients were "98.24" and "97.68 %" at pressure heads of "1" and "1.4 bar" respectively and nozzle spacing of "4 m". These data indicate that there was no remarked effect of pressure head on uniformity of distribution.

**(7) Economical view.**

- As a result of using three stage of nozzle orifice-diameters along lateral than with using one nozzle orifice-diameter, save of "120.2 L.E." which is equivalent to "362%" was obtained at the same length and conditions.

**KEYWORDS:** Bubbler - irrigation system - lateral line - nozzle - valve - uniformity distribution - manufacturing coefficient of variation - pressure head - tube with screw -head loss.

## Content

<b>TITLE</b>	<b>Page</b>
II-NTRODUCTION.....	1
II-REVIEW OF LITERATURE.....	3
2-1 Definition of irrigation system.....	3
2-2 Lateral line design.....	3
2-2-1 Head losses in lateral line.....	4
2-3 Reduction coefficient ("f" factor).....	6
2-4 Friction losses.....	8
2-5 Minor losses.....	9
2-6 Trickle irrigation-system.....	10
2-7 Description of bubbler irrigation-system.....	12
2-7-1 Advantages and disadvantages of bubbler irrigation-system.....	14
2-7-2 Design of bubbler irrigation-system.....	14
2-7-2-a Lateral line design of bubbler irrigation.....	14
2-7-2-b Delivery tube design.....	15
2-7-2-c Delivery tube elevation (bubblerriser).....	18
2-8 Coefficient of variation.....	20
2-9 Coefficient of uniformity.....	21
III- MATERIALES AND METHODES.....	23
3-1 Materials.....	23
3-1-1 Types of outlets.....	23
3-1-1-a Tubes.....	23
3-1-1-b Nozzle.....	24
3-1-1-c Innovated fittings.....	24
3-1-1-d Valve.....	24
3-1-2 Pump.....	24
3-1-3 Instruments for laboratory and field experments...	29
3-1-3-a Pressure gage.....	29

3-1-3-b Piesometric tube .....	29
3-1-3-c Graduated cylinder, stop watch, and protractor .....	29
3-1-3-d Electronic digital caliper.....	29
3-1-3-e Electrical drill and pincer.....	29
3-2 Methods.....	32
3-2-1 Laboratory experiments.....	32
3-2-1-1 Discharge.....	32
3-2-1-2 pressure.....	32
3-2-2 Field experiments.....	32
3-2-2-1 Discharge uniformity.....	32
3-2-2-2 Pressure.....	32
3-2-2-3 Determination of the extend lateral -length with several orifice-diameters.....	32
3-2-4 Coefficient of variation.....	33
3-2-5 Dimensional analysis.....	34
IV-RESULTS AND DISSCUTION.....	35
4-1 Laboratory experiments.....	35
4-1-1The effect of pressure head and tube diameter on discharge.....	35
4-1-2 The effect of pressure head and diameter of nozzle on .....	38
4-1-2-a Discharge.....	38
4-1-2-b Manufacturer's coefficient of variation.....	39
4-1-3 The effect of pressure head and diameter of outlets on discharge of innovated fitting.....	39
4-1-3-aThe effect of pressure head on discharge of innovated fitting.....	39
4-1-3-b The effect of number of thread teeth (type1), and length of screw (type2) on discharge of innovated fitting.....	45

4-1-4 The effect of valve angle on .....	47
4-1-4-a Discharge.....	47
4-1-4-b Manufacture's coefficient of variation .....	47
4-2 Field experiments.....	47
4-2-1 The effect of nozzle spacing on lateral-line length..	47
4-2-2 The effect of pressure head on lateral-line length..	54
4-2-3 The relationship between dimensionless groups.....	54
4-2-4 The effect of nozzle spacing on uniformity distribution.....	60
4-2-5 The effect of nozzles pressure head on uniformity distribution.....	60
4-2-6 The effect of valve angle and valves spacing on CUD and lateral-line length at different pressure heads.....	60
4-2-7 Economical view.....	60
V- SUMMARY AND CONCLUSION.....	65
VI- REFERENCES.....	70
VII- ARABIC SUMMARY.....	

#### List of tables

(2-1): Equivalent length for different barbed sizes.....	10
(2-2): Reduction coefficient, F, factor various numbers of equally spaced outlets along a lateral line.....	16
(3-1): The variables affect " $h/L$ " .....	34
(4-1): Discharge of tube at different tube -diameters and pressure heads.....	36
(4-2): Discharge of nozzle at different nozzle -diameters and pressure-heads.....	40
(4-3): Manufacturing coefficient of variation (CV) of nozzle at pressure head of "1.0 bar" and different nozzle -diameters.....	44

(4-4): Discharge of Innovated fitting at different pressure-heads.....	46
(4-5): Discharge of valve at different valve angles and pressure head of "1 bar" .....	51
(4-6): Manufacturing variation (CV) of valve at pressure head of "0.75 bar " and different valve-angles.....	53
(4-7): Discharge distribution along lateral line at pressure head of "1bar" and different nozzle spacings.....	55
(4-8): Discharge distribution along lateral line at pressure head of "1.4 bar" and different nozzle spacings .....	57
(4-9) : The relationship between dimensionless groups " $h/L$ ", " $qx10^{-10}/g^{1/2} d^{5/2}$ ", and " $d/s$ ".....	59
(4-10): Coefficient of uniformity distribution along lateral line at different nozzle spacings and pressure -heads .....	61
(4-11) : A comparison between using one and three-nozzle diameters along lateral line on bubbler irrigation system.....	64
<u>List of figures</u>	
2-1 : Diagram of bubbler irrigation system.	13
2-2 : Head losses gradient as a function of flow rate for four sizes of corrugated polyethylene pipe.	16
2-3 : Typical installation of bubbler irrigation system	17
2-4 : Hydraulic head, delivery hoses outlet, and ground levels as functions of distance from the water	

source.	19
3-1 : Emitters tube of different diameters.	25
3-2 : Nozzle orifices	25
3-3 : Orifice emitter.	26
3-4 : Screw fitting (type 1 and 2).	27
3-5a : Valve outlet emitter.	27
3-5b : Part details of valve emitter.	28
3-6 : Pressure gage with connector.	27
3-7 : Pisometric tube.	30
3-8 : Electronic digital caliper.	30
3-9 : Orifice pore adjusted by drilling while held by a pair of pliers.....	31
4-1 : Effect of pressure head on discharge at different tube-diameters.....	37
4-2 : Effect of tube diameter on discharge at different pressure-heads.....	36
4-3a : Effect of pressure head on discharge at different nozzle-diameters.....	41
4-3b : Effect of pressure head on discharge of nozzle at different nozzle-diameters.....	42
4-4 : Effect of nozzle diameter on discharge of nozzle at different pressure-heads.....	43
4-5 : Manufacturing coefficient of variation "CV" of nozzle at pressure head of "1 bar" and different nozzle-diameters.....	44
4-6 : Effect of pressure head on discharge of two types of innovated fitting.....	48
4-7 : Effect of number of teeth (type 1) and length of screw (type 2) on discharge at different pressure-heads.....	49

4-9 :	Manufacturing coefficient of variation "CV" of valve at pressure head of "0.75 bar" at different valve-angles.....	53
4-10 :	Discharge distribution along lateral-line at pressure head of "1 bar" and different nozzle spacings.....	56
4-11 :	Discharge distribution along lateral-line at pressure head of "1.4 bar" and different nozzle spacings.....	58
4-12 :	The relationship between dimensionless groups " $h/L$ ", " $q \times 10^{-10} / g^{1/2} d^{5/2}$ ", and " $d/s$ ".....	59
4-13 :	Effect of nozzle spacing on coefficient of uniformity distribution along lateral line at different pressure-heads.....	61