MAXIMIZING OF DISTRIBUTION UNIFORMITY FOR DRIP IRRIGATION SYSTEM USING CLOSED-CIRCUITS

By

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ABSTRACT

Aya Mohamed Ali Abo Kora: Maximizing of Distribution Uniformity for Drip Irrigation System Using Closed Circuits. Unpublished M.Sc. thesis, Department of Agricultural Engineering, Faculty of Agriculture, Ain Shams University, 2018.

The required hydraulic tests and measurements were conducted at National Irrigation Lab of Agricultural Engineering Research Institute (AEnRI), Dokki, Giza. The aim of this investigation was to enhance distribution uniformity of traditional drip irrigation system that use one single inlet of water, operation of maximization based on the technique of closed circuits with two manifolds.

The distribution uniformity is affected by both pressure distribution along pipes and hydraulic characteristics of the drippers. The selected drippers were tested under operating pressures of (50, 75, 100, 125 and 150 kPa), and the dripper irrigation lateral lengths were (35, 50, 75 and 100m). Two designs of drip irrigation were applied; first was closed circuits with two manifolds as a modification of traditional design, and the other design was the traditional with one manifold as a control.

Three types of built in drip lines of vortex drippers with flow rate of (4l/h) and two types of on line vortex dripper with flow rate of (2 and 4 l/h) were calibrated. The results indicated that the closed circuits was the best specially when using lateral lengths (75 and 100m), but the values were nearly close in case of using lateral lengths of (35 and 50m). Maximizing distribution uniformity is possible for traditional design when using self-compensating flow rate where it can reach value of 88.2% with 100m lateral length, the accepted lateral length in case of using built in drip line with 30cm spacing was 75m for closed circuits design where the **DU%** was 94% comparing with 79.2% for traditional design. The closed circuits had a significant positive effect in reducing friction head losses of non-pressure compensating built in drip line ranged from 20 to 41.7 % ,

where the percentage ranged from 10% to 50% for built in drip line with 50cm spacing – pressure compensating.

Key words: Drip irrigation, Dripper calibration, Distribution uniformity, Closed circuits, Friction head losses, Lateral lengths.

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LIST OF ABBREVIATIONS

CM1DIS	**:**	Closed circuits using one manifold
CM2DIS	**:**	Closed circuits using two manifolds
CV	**:**	Coefficient of Variation
DIC	**:**	Drip irrigation circuits
DU	**:**	Distribution Uniformity
H	**:**	Pressure head (m)
K	**:**	Constant of flow rate equation
NPC	**:**	Non- Pressure Compensating
PC	**:**	Pressure Compensating
PE	**:**	Polyethylene
PVC	**:**	Polyvinyl chloride
q	**:**	Dripper discharge (lph)
Q	**:**	Lateral discharge (lph)
$\mathbf{q}_{var}$	**:**	Dripper discharge variation
SDI	**:**	Surface drip irrigation
SSDI	**:**	Subsurface drip irrigation
TDIS	**:**	Traditional drip irrigation system
WUE	**:**	Water use Efficiency
x	**:**	Exponent of Discharge

INTRODUCTION

Distribution uniformity considered apart of successful network, the major part for developing irrigation system was new design considerations such as closed circuits using (two manifolds design) which effect on some hydraulic parameters such as distribution uniformity and coefficient of variation, using closed circuits technique has an effective role in maximizing distribution uniformity especially with long lateral lengths with different operating pressures. The influence of pressure can be presented as variable in two ways: either, directly as the average of drippers mean flow rates, or as variable percentage of flow rates variation related to the mean flow rate at the recommended operating pressure at 100 kPa, and it has many benefits over convention drip irrigation **(Singh and Rajput, 2007).**

Drip irrigation system is one of the most systems that decrease water consumption but it has some problems in some ways of modern methods of drip irrigation and it became necessary direction to make modifications and additions to the designs of drip irrigation to increase water use efficiency, reduce losses of water and improve performance, especially after the competition on water in the future climatic changes occurring. The uniformity of water is related to the pressure variation along the lateral line. The friction head losses and the lateral line inclination largely affect the pressure variation **(Sinobas and Rodríguez, 2012).**

So that the closed circuit to be considered one of the modifications to the drip irrigation system, it will add the advantages of traditional drip irrigation since it can alleviate the problem of low operational pressure at the end of the lateral lines and can reduce some problems and limitations, and the non-distribution uniformity at the lateral lines. In case of using long lines and low pressure water at the end of lateral irrigation lines ,in addition to solving the problem of the high initial cost of the method of traditional drip irrigation according to **Mansour (2012).**

The Objectives of investigation were:

1. Study the effect of the closed flow rate circuits on the problem of pressure reduction at the end stage of lateral lines.
2. Determine the difference between the two designs in terms of the pressure performance along the irrigation systems.
3. Evaluation of some hydraulic parameters such as pressure head, and friction head losses.
4. Study the impact of different drip irrigation circuits and lateral line lengths for both laterals flow rate, uniformity coefficient, and coefficient of variation.

REVIEW OF LITERATURE

2.1 Drip irrigation systems and components

El-Gindy et al. (1990) reported that, drip irrigation, discharges are applied to the soil by mechanical devices called "drippers" or "drippers" located at points are specified with specific distances along the lines. The drippers dissipate the pressure from the distribution system. The energy of the water at the application places is equal only to its potential energy and the water has essentially no velocity upon leaving the discharge device.

Evans (2000) characterized the localized irrigation system with many definitions such as trickle irrigation system, dripper irrigation system also called micro irrigation as technique which with its slow and frequent way provides drip irrigation technology. There have been many researches on the concepts of the hydraulic drip irrigation systems. These researches have a great remark on the methods and parameters used for drip-irrigation system design.

Peter et al. (2003) described the drip irrigation as a low flow rate of water emitted from a small tiny diameter hoses connected to a part of emission pipe they are located inside tubes and placed either above or under the soil surface, in drip (trickle) irrigation water is applied to the water through drippers at a small operating pressure (2-20 kPa) and at a discharge rate of about (1 - 10 l/h).The drippers are designed to be pressure dissipaters and may be different types. He add that drip irrigation systems to deliver improved water- and nutrient-use efficiency, distance between drippers and dripper flow rates must be matched to the soil's wetting characteristics and the amount and timing of water to be supplied to the crop.

Hashimshony et al. (2006) describe the drip irrigation tube having a plurality of sequentially placed drippers formed on an interior wall of the tube. Each dipper employs a series of parallel flow paths axially positioned along the tube to provide for closer proximity of inlet