Plant Archives Vol. 19, Supplement 2, 2019 pp. 548- 553 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

THE IMPACT OF DIFFERENT CLOSED DRIP IRRIGATION NETWORKS AND DRIPPER TYPE ON PRESSURE DISTRIBUTION ALONG LATERAL LINES AND UNIFORMITY

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Abstract

Field experiments were conducted at the experimental farm of NRC, El-Nubaria, Beheira Governorate, Egypt. The design of the experiment was a split-split block with a total of four replicates. The purpose of this research was to study the effect of different types of closed drip irrigation systems on the distribution of pressure on the lateral lines, friction losses and uniform distribution of points in different closed circuits. Four different types of lateral connections in which two were of single inlet type and two were of double inlet. The four closed drip irrigation systems under study have been operated and tested simultaneously to avoid temperature changes and to operate under one condition. Two types of emitters (Built-in and Online) were applied and field work was applied in the case of changing the operating pressure head to determine the effect of the change in operating pressure on the two types of points along the length of the lateral line. The results showed that the effect of lateral length and different types of lateral connections on friction head losses under different emitter type. It can be noticed that friction head losses decreased along the lateral length. It could be recommended to using the closed drip network type dual flow, where the best results are in terms of uniformity of distribution and in the lowest friction loss under different emitters types whether using built-in emitters or on-line emitters.

Keywords*:* Pressure head, Friction loss, Drip irrigation, Dripper type, Uniformity distribution, Lateral length.

Introduction

In the drip irrigation system, knowing the value of friction energy losses due to connections when the drip irrigation device is connected is very important. This is because these friction losses are very effective and direct on the design of drip irrigation system. Therefore, when studying these losses and their actual value the system will be designed and considered which will increase the efficiency of the irrigation system and provide irrigation water and the operation capacity of the drip irrigation system (Al-Misned, 2000). One of the most important features of the drip irrigation system is the addition of water and fertilizer slowly to the roots of the plant and directly through the irrigation network, which consists of a group of plastic pipes and designed to connect at the end drip irrigation devices (drippers), which add water and fertilizers regularly, drip irrigation system helps to reduce the degree of water evaporation from the surface of the soil and therefore increase the degree of water use (water use efficiency), where the formation of a wet area around the root spread area. Drip irrigation technology is characterized by increased water use efficiency (Basso *et al.,* 2008). Drip irrigation helps to reduce undesirable and negative environmental factors, thus promoting the sustainable agriculture (Valipour, 2012; Bhattarai *et al.,* 2008).

Drip irrigation has become widespread in the world due to water scarcity and scarcity concerns in many parts of the world (Sahin *et al*., 2005). Drip irrigation system is distinguished from other irrigation systems with the possibility of installation and installation in the presence of topography irregular and not good (Wei *et al*., 2003).

In drip irrigation system, laterals being less in diameter and more in length in comparison to main and sub-main pipes, contribute more towards the head loss of the system. As water travels through the laterals, pressure head loss occurs for which there is a difference of pressure between the head and tail end. Inside the emitter water travels through a predesigned path and some amount of head is lost in the process. There are also some local losses caused due to protrusion of the emitter barbs into the flow. (Eldardiry *et al*., 2015; Abd-Elmabod *et al*., 2019; Goyal and Mansour 2015; El-Hagarey *et al*., 2015; Mansour *et al*., 2015a-f; 2019a,b; 2016a-c and Wei *et al*., 2008).Operating pressure losses in local irrigation systems, which result from connections when the drip irrigation device is connected with the friction losses along the side lines, can be illustrated by tables built on Excel so that the value of the friction loss can be represented at each point Dots along the drip irrigation line can represent the total energy line of the side line that holds irrigation equipment (drippers), Hydraulic losses were calculated globally and locally, and analysis outputs were presented to determine the head losses due to the inclusion of the emitters. (Valiahary *et al*., 2014). Generally, it is possible to know the reasons for the low efficiency of the irrigation system, where the main reason is the irregularity of pressure along the side lines, and the difference in the value of the pressures is very large and uneven has the greatest impact in the low efficiency of the irrigation system and the coefficient of regularity leading to the lack of skill and management of the irrigation system Very badly (Nayak, 2007; Tayel *et al*., 2012a,b; 2015a-e; 2016; 2018; 2019).

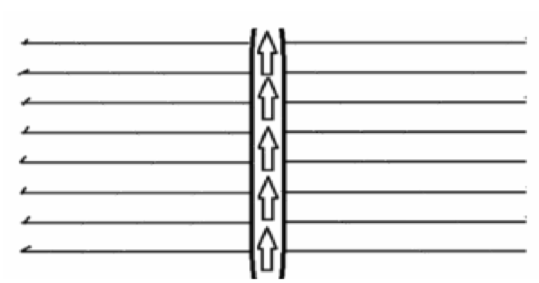
Emitters are the most sensitive part of this irrigation system and should ensure the supply of water to soil and plant, with acceptable uniformity throughout the unit to be irrigated. From the hydraulic standpoint, emitters are characterized by the required operating pressure and its nominal flow, and information regarding the flow of emitters and their flow regime is essential for the design and management of a drip irrigation system. For both, this information is obtained through characteristic equations of emitters, which are expressed by pressure-flow relationships (Yildirim, 2007; Mansour, 2015; Mansour *et al*., 2014; Mansour *et al*., 2013; Mansour *et al*., 2014; Ibrahim *et al*., 2018; Mansour and Aljughaiman 2012, 2015; Mansour and El-Melhem 2012, 2015; Attia *et al.,* 2019 and Pibars *et al*., 2015, 2019). In some cases, the difference in the shape of the dots is caused by variations in piston pressure and temperature instability during the manufacture of these dots, which is called manufacturing variation, and because the raw material mix during manufacturing was not homogenous (Kirnak *et al*., 2004). One of the most important factors affecting the system of drip irrigation is called pressure inlet, and this is in case when the pressure of entry is greater than the required operating pressure and this can have a negative impact to cause the return of water flow, and in the opposite situation if the pressure of entry less than the total the desired operating pressure can have another negative effect, which is the effect on the irregularity. In order to avoid these two bad conditions, the input pressure value must be defined with a high degree of accuracy. This will result in a balance between the input and pressure actions required to run to reach the point Operating pressure balance of the elves line Z which carries irrigation devices it (Yildirim and Agiralioglu, 2008). (Deba , 2008) has made special calculations to determine the value of entry pressure in the drip irrigation system and to determine the most important factors of the operation of the irrigation system, namely pressure entry and water flow system drip irrigation.The objectives of current research were to study the effect of different types of closed drip irrigation systems on the distribution of pressure along the lateral lines, friction losses and uniformity coefficient of different closed drip irrigation networks.

Material and Methods

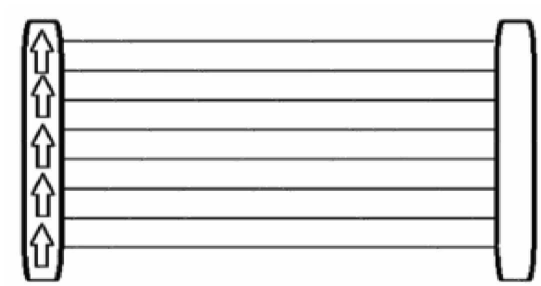
Field experiments were conducted at the experimental farm of NRC, El-Nubaria, Beheira Governorate, Egypt. The experimental design of field experiments was split block design with four replicates. The main idea in the planning of the present work done in the field to study the pressure distribution and performance of two emitters types on different types of closed drip irrigation networks. Similarly, four different types of lateral connections in which two were of single inlet type and two were of double inlet.

The proposed networks were operated at the same circumstances. Two different types of emitters (online and built-in) were used in the field work the two cases with different pressures values.

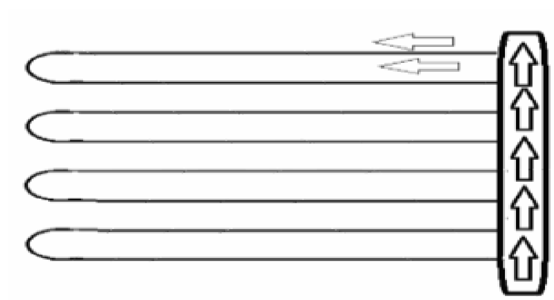
Figure 1. Shown the different closed drip irrigation networks under study. Irrigation networks included the following components: 1) Control head: It was located at the water source supply. It consists of a centrifugal pump 3"/3", driven by electric engine (pump discharge of 80 m^3/h and 40 m lift), sand media filter 48" (two tanks), screen filter 2" (120 mesh), back flow prevention device, pressure regulator, pressure gauges, flow-meter, control valves and chemical injection port. 2) Main line: PVC pipes of 75 mm in (ID) to convey the water from the source to the main control points in the field. 3) Sub- main lines: PVC pipes of 75 mm in (ID) were connected to with the main line through a control unit consists of a 2" ball valve and pressure gauges. 4) Manifold lines: PVC pipes of 50 mm in (ID) were connected to the sub main line through control valves 1.5". 5) Lateral lines: PE tubes of 16 mm in (ID) were connected to the mani-folds through beginnings stalled on manifolds lines. 6) Emitters: These emitters (GR) and Orifice emitter are built in PE tubes 16 operating pressure and 30 cm spacing in-between. The components of closed circuits of the drip system include, supply lines, control valves, supply and return manifolds, drip lateral lines, emitters, check valves and air relief valves/vacuum breakers (Mansour *et al*., 2019).



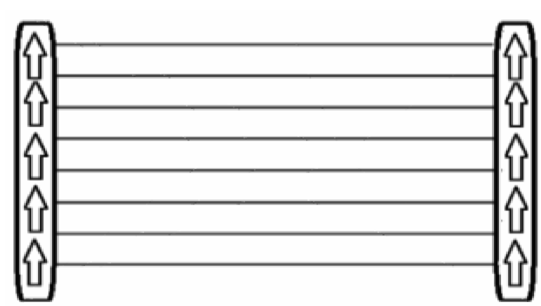
A. Flash pipe



B. Closed end



C. Loop tube



D. Dual flow

Fig. 1 : Different types of closed drip irrigation networks: A. Flash pipe, B. Closed end, C. Loop tube and D. Dual flow.

The flow rate through the pipe depends on pipe surface roughness and air layer resistance. The change of hydraulic friction coefficient values, depending on variations in Re number values. Hydraulic losses at plastic pipes might be calculated as losses at hydraulically smooth pipes, multiplied by correction coefficients that assess losses at pipe joints and air resistance.

The energy loss (or head loss) in pipes due to water flow is inversely proportional to the pipe's length.

$$J = (H / L) \times 100$$

where

J = The head loss coefficient in a pipe is usually (%) or m/100 m,

ΔH = change in water head (m), and

L = length of tube (m).

to evaluate uniformity of water application from trickle (drip) irrigation systems in the field and classified the systems on the bases of system uniformity. They expressed field emission uniformity as follows:

$$EUf = \{(q1/4) / qa\} \times 100$$

Where:

EUf = field emission uniformity expressed as a percentage

q1/4 = average discharge of the emitters on quarter of the area receiving the least amount in the tested subunit, lph.

qa = average emitter discharge in the subunit, lph,

Statistical analysis: COSTAT program was used to carry out Statistical Analysis. The treatments means were compared using the technique P of analysis of variance (ANOVA) and the least significant difference between systems at 5 %.

Results and Discussions

Effect of lateral length and different types of lateral connections on friction head losses under different emitter type

Figures 2 and 3 showed the effect of lateral length and different types of lateral connections on friction head losses under different emitter type It can be noticed that friction head losses decreased along the lateral length.

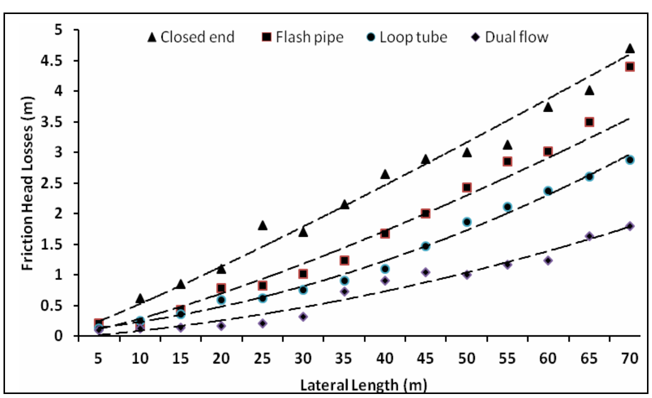


Fig. 2 : Effect of lateral length and different types of lateral connections on friction head losses under built-in emitter

The results obtained that The treatment of dual inlet water and built-in emitter surpassed the single inlet water and on emitters, the maximum lateral length of the line can be obtained is 36 and 30 meters for the built-in and on emitters respectively in closed end, whereas in flash pipe the maximum lateral length was 45 and 40 m obtained under built-in and on line emitters respectively .

While in loop tube the lateral length can be reach 52 and 48m at built in emitter and on emitter respectively.

Dual inlet flow, in this case the length of lateral can be reached 60 m without the occurrence of a decrease in pressure affecting the flow.

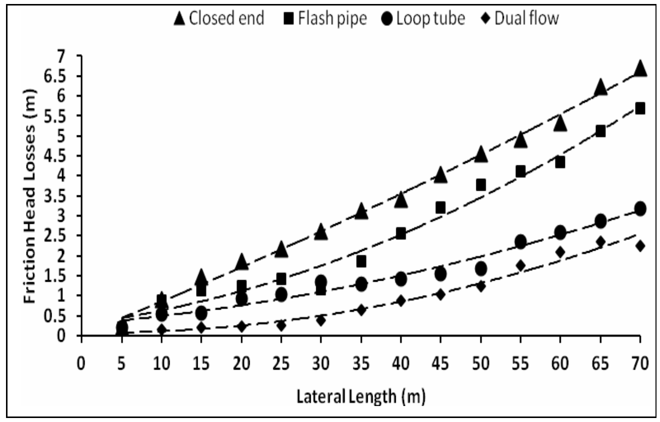


Fig. 3 : Effect of lateral length and different types of lateral connections on friction head losses under online emitter

Characteristics of the evaluation of the closed drip irrigation system

The system of closed drip irrigation systems aims to increase the flow of water and increase the efficiency of the irrigation system, thus making the rate of discharge of the points acceptable by more than 20%. Figures 4 and 5 shown the emission uniformity under different closed drip systems networks by using different emitters types.

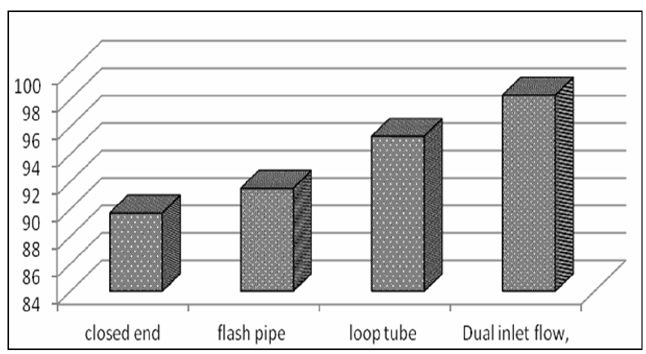


Fig. 4 : Effect of lateral connections on emission uniformity under built-in emitter type.

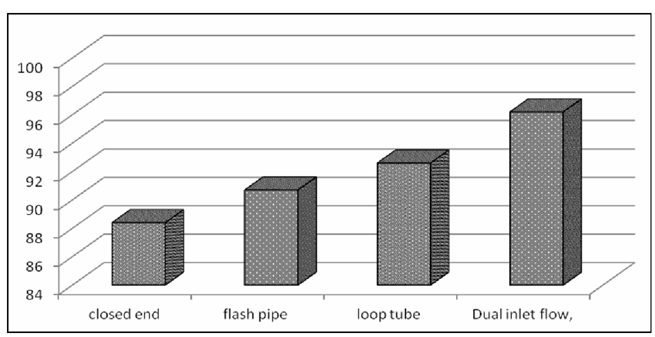


Fig. 5 : Effect of lateral connections on emission uniformity under on-line emitter type.

The results of the current study showed that the dripper discharge rates variation 89.7%, 91.5%, 95.3 and 98.3 % were obtained under in-line emitter and 88.4%, 90.7%, 92.6 and 96.2 % were obtained under on-line emitter for closed end, flash pipe, loop tube and Dual inlet flow respectively, these results indicate that the drip irrigation system was good and sufficient in terms of the regularity of the distribution of points when tested individually. If there is a wide variation and differences between the actions of the points, this will lead to irregularity, which causes poor efficiency of the closed irrigation system. Christian is 96% for the system of drip irrigation,

The low and low uniformity means that there are some areas in the field that do not reach the quantity of the pastures in a form that is adequate and suitable for other areas that reach the water more than necessary and this will lead to accumulation of salt concentration in the areas of the few water and therefore the lack of yield in those areas of the field and Where the values of uniformity coefficient were 99%, 74% and 68%.

Discussion

When using different types of drips, whether it is online or built-in, it was concluded that drip irrigation system of the dual flow type was the best in terms of the least value of friction losses along the drip irrigation line followed by the closed drip irrigation network of loop tubes. The closed drip type of flash pipe Finally, the closed drip irrigation system and the largest value in friction losses is closed end type. These results have been agreed with results by Mansour and Aljughaiman, (2012) and Tayel *et al*. (2012 a; b), Mansour *et al*. (2015a, b, c, d), Tayel *et al*. (2016), Pibars and Mansour, (2015), Pibars and Mansour (2016), and Mansour *et al*. (2014).

This resulted in the uniformity of the distribution of the behavior in the case of the use of different types of points, whether the type of online or built-in were in the same order where the best in the regularity of the distribution is a closed drip irrigation system of the dual flow followed by a network of closed drip irrigation type loop tube and This is the closed piping system of the flash pipe type. Finally, the closed drip irrigation network was the lowest in the distribution uniformity of closed end. These results have been agreed with results by Mansour and Aljughaiman (2012) and Tayel *et al*. (2012 a, b); Mansour *et al*. (2015a, b, c, d), Tayel *et al*. (2016), Pibars and Mansour, (2015), Pibars and Mansour (2016) and Mansour *et al*. (2014).

Conclusion

It could be concluded to using the closed drip network type dual flow, where the best results are in terms of uniformity of distribution and also in the lowest friction loss, when tested using different lengths of the emitter line and also using different emitters types whether using built-in emitter or the other type is on-line emitter.

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