MODIFICATION OF WATER APPLICATION UNIFORMITY AMONG CLOSED CIRCUIT TRICKLE IRRIGATION SYSTEMS

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ABSTRACT

*The aim of this research was determine the maximum application uniformity of closed circuit trickle irrigation systems designs. Laboratory tests carried out for Two types of closed circuits: a) One manifold for lateral lines or **C**losed circuits with **O**ne **M**anifold of **T**rikle **I**rrigation **S**ystem (COMTIS); b) **C**losed circuits with **T**wo **M**anifolds of **T**rikle **I**rrigation **S**ystem (CTMTIS), and c) **T**raditional **T**rikle **I**rrigation **S**ystem (TTIS) as a control. Three lengths of lateral lines were used, 40, 60, and 80 meters. PE tubes lateral lines: 16 mm diameter; 30 cm emitters distance, and GR built-in emitters 4 lph when operating pressure 1 bar. Experiments were conducted at the Agric. Eng. Res. Inst., ARC, MALR, Egypt. With COMTIS the emitter flow rate was 4.07, 3.51, and 3.59 lph compared to 4.18, 3.72, and 3.71 lph with CTMTIS and 3.21, 2.6, and 2.16 lph with TTIS (lateral lengths 40, 60, and 80 meter respectively). Uniformity varied widely within individual lateral lengths and between circuit types. Under CTMTIS uniformity values were 97.74, 95.14, and 92.03 %; with COMTIS they were 95.73, 89.45, and 83.25 %; and with TTIS they were 88.27, 84.73, and 80.53 % (for lateral lengths 40, 60, 80 meter respectively). The greatest uniformity was observed under CTMTIS and COMTIS when using the shortest lateral length 40 meter, then lateral length 60 meter, while the lowest value was observed when using lateral length 80 meter this result depends on the physical and hydraulic characteristics of the emitter and lateral line. CTMTIS was more uniform than either COMTIS or TTIS. Friction losses were decreased with CTMTIS in the emitter laterals at lengths 40 meter compared to TTIS and COMTIS. Therefore, differences may be related to increased friction losses when using TDIS and COMDIS.*

KEYWORDS. Trickle Irrigation, Closed Circuits, Manifold, Lateral, Flow Rate, Uniformity.

INTRODUCTION

Trickle irrigation has been used since ancient times when buried clay pots were filled with water, which would gradually seep into the grass. Perforated pipe was introduced in Germany in the 1920s and in 1934, Nobey experimented with irrigating through porous canvas hose at Michigan State University. Plastic microtubing and various types of emitters began to be used in the greenhouses of Europe and the United States.

Qualitative classification standards for the production of emitters, The emitter discharge rate q (m^3/h) has been described by a power law, $q = kH^x$, where operating pressure head H (m), emitter coefficient (k), and exponent (x) depend on emitter characteristics **(Kırnak *et al* 2004). Capra and Scicolone (1998)** indicated that the major sources of emitter flow rate variations are emitter design, the material used to manufacture the lateral line, and precision. According to **Mizyed and Kruse (1989)** the main factors affecting trickle irrigation system uniformity are: (1) manufacturing variations in emitters and pressure regulators, (2) pressure variations caused by elevation changes, (3) friction head losses throughout the pipe network, (4) emitter sensitivity to pressure and irrigation water temperature changes, and (5) emitter clogging. Similarly, according to the manufacturer's coefficient of emitter variation (CV_m), have been developed by ASAE. CV_m values below 10% are suitable and > 20% areunacceptable **(ASAE, 2003).** The emitter discharge variation rate (q_{var}) should be evaluated as a design criterion in trickle irrigation systems; q_{var} < 10% may be regarded as good and q_{var} > 20% as unacceptable **(Wu & Gitlin, 1979 and Camp *et al* 1997).** The acceptability of micro-irrigation systems has also been classified according to the statistical parameters, Uqs and EU; namely, EU = 94%-100% and Uqs = 95%-100% are excellent, and EU < 50% and Uqs < 60% are unacceptable **(ASAE, 1996). Ortega *et al* (2002)** calculated emission uniformity (EU), pressure variation coefficient (VCp), and flow variation coefficient per emitter (VCq) at localized systems and reported that they were 84.3%, 0.12, and 0.19, respectively. They classified the systems unacceptable for VCq > 0.4 and excellent for VCq < 0.1. In addition to pressure variation along irrigation tape, variation in emitter structure or

emitter geometry has been known to cause poor uniformity of emitter discharge **(Wu & Gitlin, 1979; Alizadeh, 2001 and Kırnak *et al* 2004).** Differences in emitter geometry may be caused by variation in injection pressure and heat instability during their manufacture, as well as by a heterogeneous mixture of materials used for the production **(Kırnak *et al* 2004). Berkowitz (2001)** observed reductions in emitter irrigation flow ranging from 7 to 23% at five sites observed. Reductions in scouring velocities were also observed from the designed 0.6 m/s (2ft/s) to 0.3 m/s (1ft/s). Lines also developed some slime build-up, as reflected by the reduction in scouring velocities, but this occurred to a less degree with higher quality effluent. In their treatments they generally used approximate friction equations such as Hazen-Williams and Scobey, neglected the variation of the velocity head along the lateral and assumed initial uniform emitter flow. **Warrick & Yitayew, 1988 and Yitayew & Warrick, 1988** assumed a lateral with a longitudinal slot and presented design charts based on spatially varied flow. The latter solution has neglected the presence of laminar flow in a considerable length of the downstream part of the lateral. **Hathoot *et al* 1991** provided a solution based on uniform emitter discharge but took into account the change of velocity head and the variation of Reynold's number. They used the Darcy-Weisbach friction equation in estimating friction losses. **Hathoot *et al* 1993** considered individual emitters with variable outflow and presented a step by step computer program for designing either the diameter or the lateral length. In this study we considered the pressure head losses due to emitters protrusion. These losses occur when the emitter barb protrusion obstructs the water flow. Three sizes of emitter barbs were specified, small, medium and large in which the small barb has an area equal or less than 20 mm^2, the medium barb has an area between 21-31mm^2 and the large one has an area equal to or more than 32 mm^2 **Watters *et al* 1977**.

The objectives of the present research were:

1. Recovery the problem of pressure reduction at the end stage of lateral lines.
2. Investigate emitter discharge application uniformity and its dependence on operation pressures and Laterals lengths (40, 60, and 80 m).

3. To compare emitter discharge uniformity between tow type of closed circuits (COMTIS and CTMTIS) and traditional trickle system (TTIS).

MATIRIALS AND METHODS

Site Location and Experimental Design

This experiment was conducted at Irrigation Devices and Equipments Tests Laboratory, Agricultural Engineering Research Institute, Agriculture Research Center, Cairo, Egypt, The experimental design was randomized complete block with three replicates. Three irrigation new lateral lines 40, 60, 80 m long that were installed at constant level and under Ten operating pressures 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, and 2.0 bar for Ten minutes at each pressure. Details of the pressure and water supply control have been described by **(Safi *et al* 2007),** to evaluate the Built-in Dripper (GR), discharge, 4 lph design emitter spacing of 30 cm at 1 bar nominal operating pressure in order to reach an modified way to resolve the problem of lack of pressure at the end of lateral lines in the traditional trickle irrigation system.

Drip System Components

The components of closed circuits the trickle system include, supply lines, control valves, supply and return manifolds, trickle lateral lines, trickle emitters, check valves and air relief valves/vacuum breakers. **Figures (1 and 2)** show the closed circuits of trickle irrigation system: 1). Closed circuit with Tow Manifold of trickle Irrigation System **(CTMTIS)** and 2). Closed circuit with One Manifold of trickle Irrigation System **(COMTIS)** while **Fig. (3)** is 3).Traditional of Trickle Irrigation System **(TTIS)**. Supply lines provide water to the supply manifolds of the system after passing through the zone control valve in systems with more than one zone. The supply manifold distributes water to the individual trickle laterals within the zone. The laterals then connect to a return manifold. Along the supply and return manifold, air relief/vacuum breakers are installed at the highest point of the manifolds to allow air to enter the system during depressurization **(Netafim, 2002).**

The return manifold is used during system flushing to collect water from the laterals and carry it to the return line which returns to the pretreatment device. Prior to connecting the return manifold to the return line a check

valve is installed to prevent water from entering the zone during the operation of other zones.

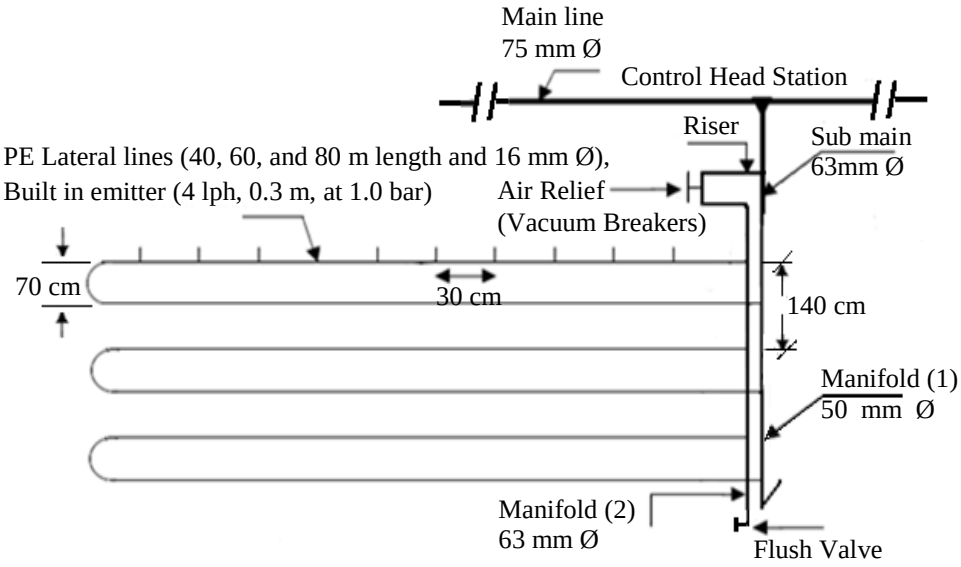

Fig. 1. Layout of Closed circuit with Tow Manifolds of Trickle Irrigation System (CTMTIS).

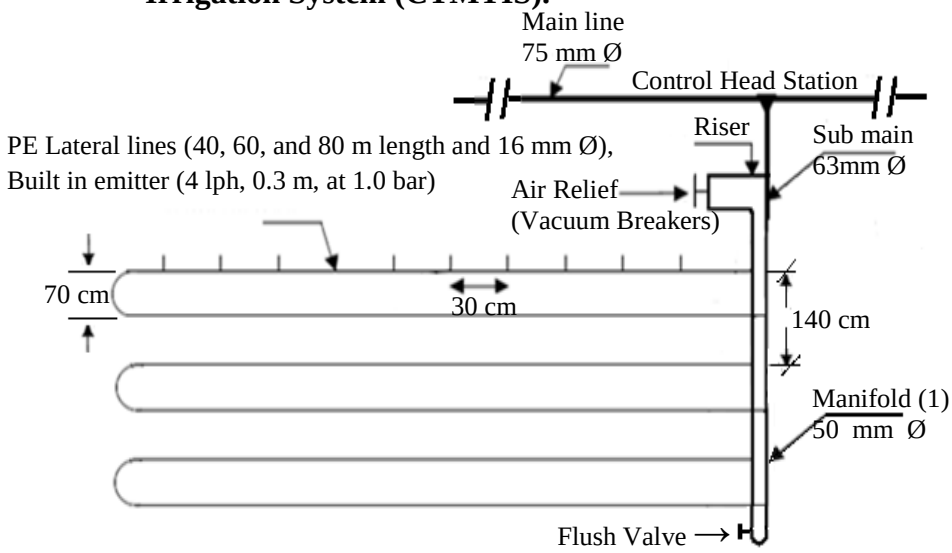

Fig. 2. Layout of Closed circuits with One Manifold of Trickle Irrigation System (COMTIS).

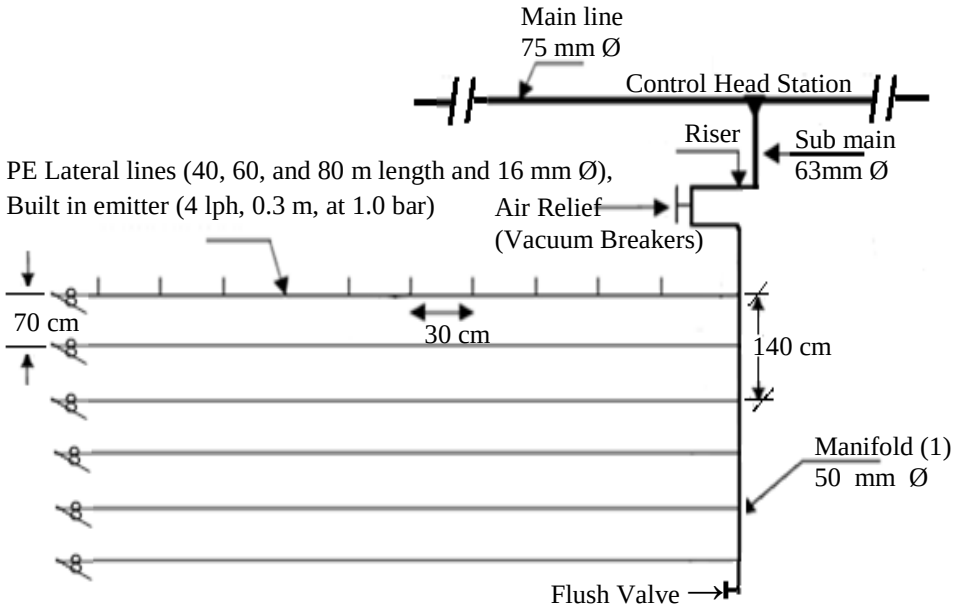

Fig. 3. Layout of Traditional Trickle Irrigation System (TTIS).

$$q_{var} = \frac{q_{max} - q_{min}}{q_{max}} \quad (1)$$

$$CV = \frac{S}{\bar{q}} \quad (2)$$

$$UC = 100\left[\frac{\frac{1}{n}\sum_{i-1}^{n}|qi-\bar{q}|}{\bar{q}}\right] \quad (3)$$

Where:

q_{max} and q_{min} are maximum and minimum emitter discharge, respectively,

$\bar{q}$ and S are the mean and standard deviation, respectively, of discharge (q), and

n is the number of emitters.

Emission uniformity of the quarter was calculated using the equation **(Ortega *et al* 2002)**

$$EU(\%) = \frac{\overline{q_{25\%}}}{q}\,100 \quad (4)$$

Where:

$\bar{q}_{25\%}$ is the mean of the lowest 0.25 of emitter discharge.

The coefficient of variation in this calculation refers to the depth of water applied. This statistical uniformity coefficient describes the uniformity of

water distribution assuming a normal distribution of flow rates from the emitters.

Application uniformity of a system is affected by hydraulic design, topography, operating pressure, pipe size, emitter spacing, and emitter discharge variability. Discharge variability is due to manufacturer's coefficient of variation, emitter wear, and emitter plugging **ASAE (1999).** **Table 1** illustrates the acceptability depending on the range of statistical uniformity. **ASAE (1983)** also represents flow variation through the Christiansen Uniformity Coefficient:

$$C_u = 1 - \frac{\overline{\Delta q}}{\bar{q}} \qquad (5)$$

Where:

C_u = the uniformity coefficient %,

$\bar{q}$ = the mean emitter flow (lph), and

$\overline{\Delta q}$ = the mean absolute deviation from the mean emitter flow(lph).

Table 1. Methods of comparison of statistical uniformity (ASAE, 1999).

Method Acceptability	Statistical Uniformity, Us (%)
Excellent	95-100
Good	85-90
Fair	75-80
Poor	65-70
Unacceptable	<60

An additional method of evaluating the application uniformity of a system is described in **Burt *et al* (1997).** This method uses a distribution uniformity using the average depth of application of the lower quartile over the average depth of application (equation 8). This method has been used by USDA and NRCS since the 1940s.

$$DUlq = \frac{avg._{low} - quarter\ depth}{avg.depth\ of\ water\ accumulated\ in\ allelements} \qquad (6)$$

Head Loss in a Pipe

The head loss in pipes due to water flow is proportional to the pipe's length.

$$J = \frac{\Delta H}{L} \quad \textbf{(7)}$$

Where: J = The head loss in a pipe is usually expressed by either %.

The head loss due to friction is calculated by Hazen-Williams equation:

$$J = 1.21x10^{12}(\frac{Q}{C})^{1.852}D^{-4.87} \quad \textbf{(8)}$$

Where

J = head loss is expressed by (m/100 m) or %.

Q = flow rate is expressed by m^3/h.

D = Inside diameter of a pipe is expressed by mm.

C = (Hazen-Williams coefficient) smoothness (the roughness) of the internal pipe, (the range for a commercial pipe is 100 – 150)

For polyethelene tubes when diameter < 40 mm and (C = 150). **Mogazhi (1998) and Bombardelli and Garcia(2003).**

Hathoot, *et al* (1998). For laminar flow where R≤ 2000 the coefficient of friction is given by:

$$f = \frac{64}{R} \quad \textbf{(9)}$$

in which R, Reynolds number is given by:

$$R = \frac{VD}{\nu} \quad \textbf{(10)}$$

Where: R = Reynolds number,

V = flow velocity (m/s),

D = inside diameter (m), and

ν = kinematic viscosity of irrigation water.

Critical velocity could be calculated by (10) and the following equations.

For turbulent flow ($3000 < R \leq 10^5$) the Blasius equation can be used:

$$f = 0.316R^{-0.25} \quad \textbf{(11)}$$

For fully turbulent flow, $10^5 < R < 10^7$, **Watters and Keller (1978)** recommended the following equation:

$$f = 0.13R^{-0.172} \quad \textbf{(12)}$$

Statistical analysis

All the collected data were subjected to the statistical analysis as the usual technique of analysis of variance (ANOVA) and the least significant difference (L.S.D) between systems at 5% had been done according to **Dospekhov (1984)**.

RESULTS AND DISCUSSION

The effect of closed circuits at different laterals lengths on emitter discharge and the cumulative flow lines subsidiary.

1. Closed circuits with tow manifolds of trickle irrigation system(CTMDIS):

Data of **Fig. (4-A, B, and C)** indicate the effect of closed circuits with tow manifolds of trickle irrigation system (CTMTIS) at different laterals lengths (40, 60, and 80 m) on dripper flows and the Cumulative flows lines subsidiary. Under the lateral lines length (40 m), emitter flow was the highest value (4.18 Lph), then came the lateral line length (60 m) value was (3.72 Lph). The lowest value was (3.71 Lph) achieved under lateral line length (80 m). While as for the cumulative flow under lateral length (80 m) was the highest (990.0 Lph), then lateral length (60 m) (744.0 Lph), while the lowest value of the cumulative flow was (599.9) under lateral length (40 m) as show **Fig. (4-A, B and C)** at (1.0 bar) operating pressure and under the laboratory conditions as stated by **Perlod, 1977; Watters & Keller, 1978; Gilbert *et al* 1979 and Khatri *et al* 1979.** There were significant differences at the 5% level in the emitters flow and the cumulative flows between any two lateral lengths of CTMTIS. The increase in emitters flow and the cumulative flows under CTMTIS were 23.21, 23.36 ; 30.11, 30.10 and 41.78, 41.74 % under lateral lengths 40 ; 60 and 80 m, respectively in comparison with the

control values of traditional trickle irrigation system TTIS as show **Table (3)** and the same **Fig.(4-A, B, and C).**

2.Closed circuits with one manifold of trickle irrigation system(COMTIS):

Data of **Fig. (5-A, B, and C)** indicate the effect of closed circuits with one manifold of trickle irrigation system (COMTIS) at different laterals lengths (40, 60, and 80 m) on emitter flows and the Cumulative flows lateral lines. According to emitter flows of the laterals lengths could put in the following ascending orders Lateral Length 60m (3.51 lph) < Lateral Length 80m (3.59 lph) < Lateral Length 40 m (4.07 lph). Concerning to cumulative flow per line, It is obvious that the lateral lengths under study when using (COMTIS) method could be arranged in the following ascending order Lateral Length 40m (541.0 lph) < Lateral Length 60m (702.0 lph) < Lateral Length 80 m (958.0 lph). On the other hand under (TTIS) at different laterals lengths (40, 60, and 80 m) on emitter flows and the Cumulative flows lateral lines. According to emitter flows of the laterals lengths could put in the following descending orders Lateral Length 40 m (3.21lph) < Lateral Length 60m (2.60 lph) < Lateral Length 80m (2.16 lph). Concerning to cumulative flow per line, It is obvious that the lateral lengths under study when using (TTIS) method could be arranged in the following descending order Lateral Length 80 m (576.7 lph) < Lateral Length 60m (520.0 lph) < Lateral Length 40m (426.0 lph) as show **Fig. (5-A, B and C)** at (1.0 bar) operating pressure under the laboratory conditions as stated by **Perlod, 1977 ; Watters and Keller, 1978 ; Gilbert *et al.*, 1979 and Khatri *et al.*, 1979.**

There were significant differences at the 0.05 level in the emitters flow and the cumulative flows between any two lateral lengths of COMTIS. The increase in emitters flow and the cumulative flows under COMTIS were 21.13, 21.26 ; 25.92, 25.90 and 39.83, 39.81% under lateral lengths 40 ; 60 and 80 m, respectively in comparison with the control values of traditional trickle irrigation system TTIS as show **Table (3)** and the **same Fig.(5-A, B, and C).** We can note from the **Figures 5 and 6** that the flow of emitters became a regular at the end of the line, such as first-line using the methods amended (CTMTIS and COMTIS), and this was due to irregular pressure lines, the Sub-corrected methods compared with the

system of traditional as well as from the values of the percentages of decrease in pressure values in **Table (2).**

3. Uniformity coefficient under different lateral lengths of closed circuits methods:

Uniformity coefficient under CTMTIS were the highest values (97.74; 95.14 and 92.03%), then COMTIS (95.73; 89.45 and 83.25%), while the lowest values of uniformity coefficient was (88.27 ; 84.73 and 80.53%) under TTIS

Table (2). Effect of the closed circuits irrigation methods on emitter flow and cumulative flow.

Irrigation Method	Lateral Length (m)	Emitter Flow (Lph)	Reduction Pressure (%)	Cumulative Flow (Lph)
CM2DIS	**40**	4.18	3.70	555.9
	60	3.72	5.60	744.0
	80	3.71	7.00	990.0
CM1DIS	**40**	4.07	3.99	541.0
	60	3.51	6.10	702.0
	80	3.59	8.90	958.0
TDIS	**40**	3.21	8.35	426.0
	60	2.60	13.87	520.0
	80	2.16	30.58	576.7
LSD 0.05		0.03	0.24	3.3

when using three laterals line lengths (40, 60 and 80 m), respectively as stated by **(ASAE, 2003)**. as **show Table (4).** LSD 0.05 value was (2.5) and (2.1) show that there are significant differences in uniformity coefficient between all lateral lengths in each connection methods of irrigation, with the exception of that between CTMTIS and COMTIS in the same lateral lengths 40m. The increases percentage in uniformity coefficient under CTMTIS were (9.68; 10.94 and 12.49 %), while the increases percentage under COMTIS were (7.79; 5.27 and 3.26 %) at three lateral lengths 40, 60, and 80 m, respectively relative to TTIS). According to the uniformity coefficient, The interaction between the connection methods and lateral lengths treatments was significant, as stated **(Wu and Gitlin, 1979; Camp *et al* 1997; ASAE, 1996 and Ortega *et al* 2002)** about the classification of acceptability of trickle irrigation system**.**

The variation in uniformity coefficient between the lateral lengths under CTMTIS and COMTIS according to LSD at 0.05 values and **Fig. (6)** Due

to hydraulics, and adjusted friction loss in lateral lines values for new irrigation methods are shown in **Fig. (7).**

4. Effect of closed circuits methods and lateral length on friction loss.

According to friction loss as show **Fig. (7),** the lowest values (0.05; 0.13 and 0.17 bar) were under CTMTIS, then COMTIS values of friction loss

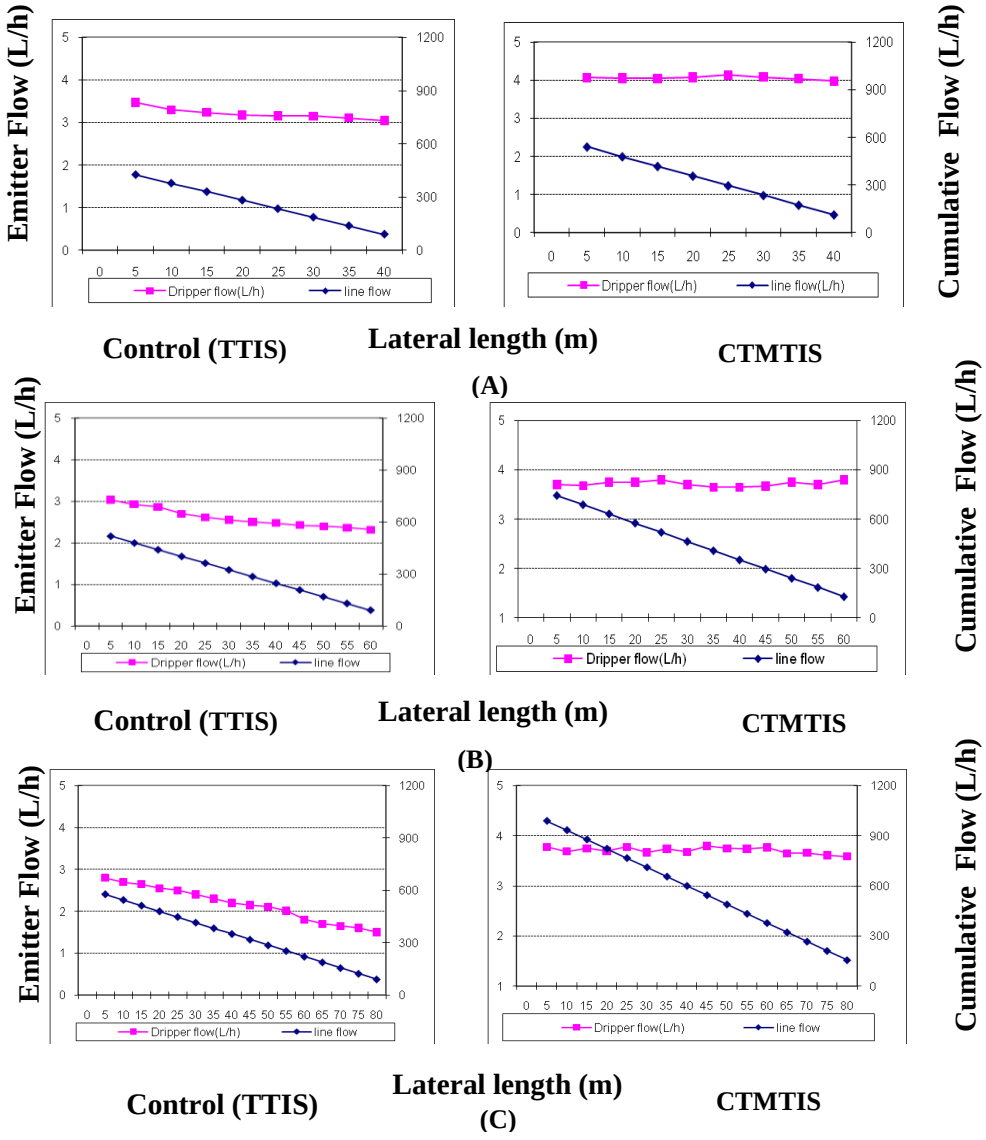

Fig. 4. Comparing emitters flow uniformity between different lateral lines lengths in a closed circuits by using tow manifold lines (CTMTIS) and trickle traditional system (TTIS).

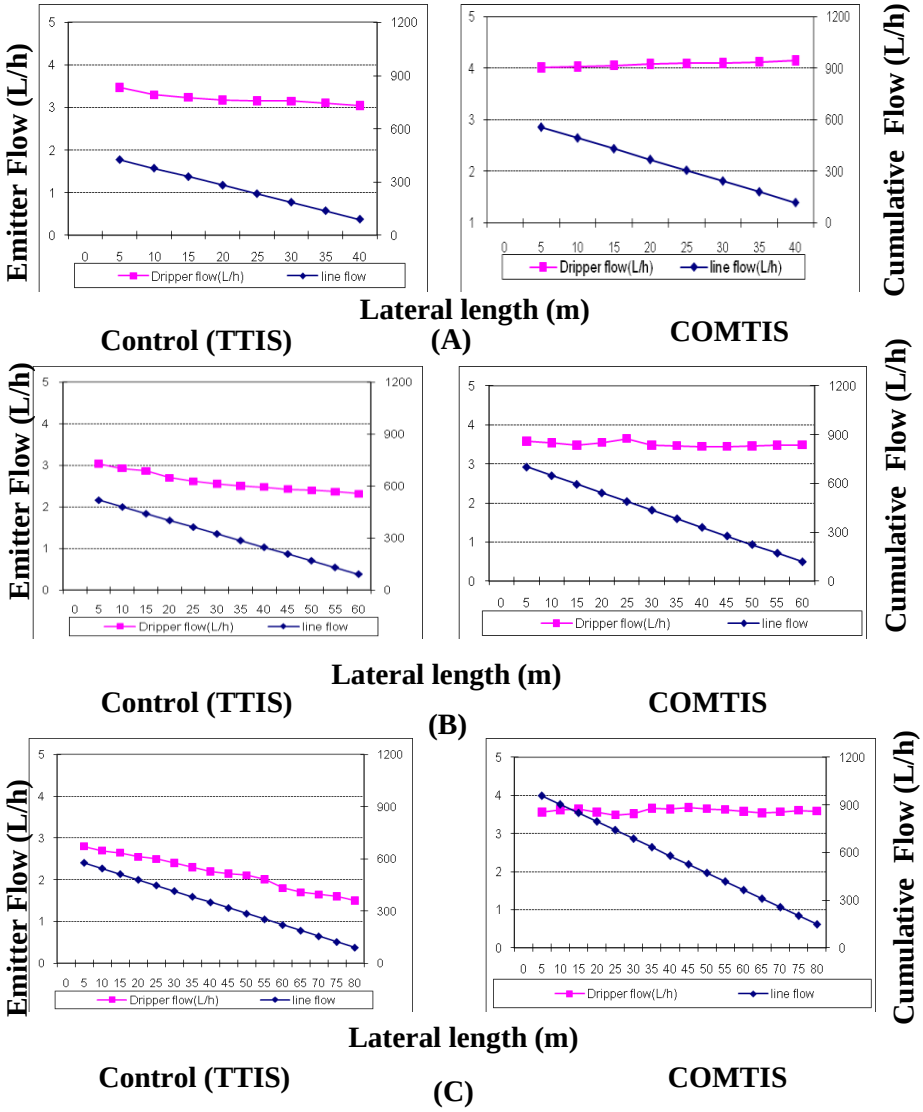

Fig. 5. Comparing emitters flow uniformity between different lateral lines lengths in a closed circuits by using tow manifold lines (CTMTIS) and trickle traditional system (TTIS).

were (0.08; 0.17 and 0.25 bar), while the highest values were under TTIS (0.114; 0.221 and 0.4 bar) when using three lateral lines lengths (40; 60 and 80 m), respectively as stated by **Warrick & Yitayew, 1988; Yitayew & Warrick, 1988: Hathoot *et al* 1991 and Hathoot *et al* 1993**.

The variation in uniformity coefficient between the lateral lengths under CTMTIS and COMTIS according to LSD at 0.05 values and **Fig. (6)** Due to hydraulics, and adjusted friction loss in lateral lines values for new irrigation methods are shown in **Fig. (7).**

4. Effect of closed circuits methods and lateral length on friction loss.

According to friction loss as show **Fig. (7),** the lowest values (0.05; 0.13 and 0.17 bar) were under CTMTIS, then COMTIS values of friction loss were (0.08; 0.17 and 0.25 bar), while the highest values were under TTIS (0.114; 0.221 and 0.4 bar) when using three lateral lines lengths (40; 60 and 80 m), respectively as stated by **Warrick & Yitayew, 1988; Yitayew & Warrick, 1988: Hathoot *et al* 1991 and Hathoot *et al* 1993**. As show LSD 0.05 values in **Table (4)** there are significant differences in friction loss values between all lateral lengths and all methods. The decrease percentage in friction loss under CTMTIS were (56.14; 41.17 and 57.50 %), while the decrease percentage under COMTIS were (29.82; 23.07 and 37.50) at three lateral lengths (40; 60 and 80), respectively. According to the friction losses, The interaction between the connection methods and lateral lengths treatments was significant and the main reason of increase uniformity coefficient of closed circuits methods CTMTIS and COMTIS is that the friction loss decreased significantly under these methods Data as we can note the data in **Tables (3and 4)**

Table (3): Effect of closed methods and lateral lengths on uniformity coefficient (%) and friction loss (bar).

Irrigation connection Method	Lateral Length (m)	Uniformity Coefficient,%	Coefficient Variation (CV)	Acceptability By ASAE 1996	Friction Loss (bar)
CTMTIS	**40**	97.74	0.08	Excellent	0.050
	60	95.14	0.06	Excellent	0.130
	80	92.03	0.12	good	0.170
COMTIS	**40**	95.73	0.07	Excellent	0.080
	60	89.45	0.16	good	0.170
	80	83.25	0.23	good	0.250
TTIS	**40**	88.27	0.18	good	0.114
	60	84.73	0.22	good	0.221
	80	80.53	0.28	fair	0.400
LSD 0.05		0.21			0.01

Table (4): Effect of operating pressures 1.0 bar on the flow parameters of PE lateral tubes .

Hydraulic Parameters	LL (m) of TTIS			LL(m) of CTMTIS			LL (m) of COMTIS		
	40	**60**	**80**	**40**	**60**	**80**	**40**	**60**	**80**
No. Drippers	133	200	267	133	200	267	133	200	267
Emitter (Q) (lph)	3.21	2.60	2.16	4.18	3.72	3.71	4.07	3.51	3.59
Total (Q) (lph)	427	520	577	556	744	990	541	702	958
Velocity avg. m/s	0.94	1.62	1.97	0.86	1.54	1.88	0.91	1.73	1.92
Renold Number	3234	3489	3612	3238	3001	3062	3859	3753	3810
Flow Type	Turbulent								
Critical Velocity	0.89	1.58	1.93	0.82	1.48	2.83	0.87	1.68	1.85
f = Ɛ /d	0.23								
Hf (bar)	**0.114**	**0.221**	**0.400**	**0.050**	**0.130**	**0.170**	**0.080**	**0.170**	**0.250**

Ɛ /d = Roughens Coefficient; LL = Lateral Length (m); Rn>3000=Turblent flow; Rn <3000 = Laminar flow.

The study is confirms that the closed circuits of trickle irrigation systems (CTMTIS) and (COMTIS) by some modifications in manifolds and laterals are; generally, polyethylene pipes of (0% slope) fixed level and fitted with similar and equally spaced emitters whose discharges usually decrease in the head losses along the lines with flow direction which led to that increase in the above-described Uniformity coefficients as show **Tables (3 and 4) and Figure (6 and 7).** Many investigators provided approximate solutions for the problem of trickle irrigation lateral design. Among the earlier investigators were **Perlod, 1977 ; Watters & Keller, 1978 ; Gilbert *et al* 1979 and Khatri *et al* 1979.**

5. Effect of different operating pressures on emitters discharge of lateral lines closed circuits:

In **Table (5)** we can be observed there was a direct relationship between the operating pressures and the average discharge of lateral lines along the lines in all cases and this is logical.When operating pressure 0.8 bar was under used CTMTIS method, the average of emitter discharge when lateral length 40 m was 4.48 Lph and when using the COMTIS and the value of the average discharge of emitter was 4.20 Lph under the same length of the line.

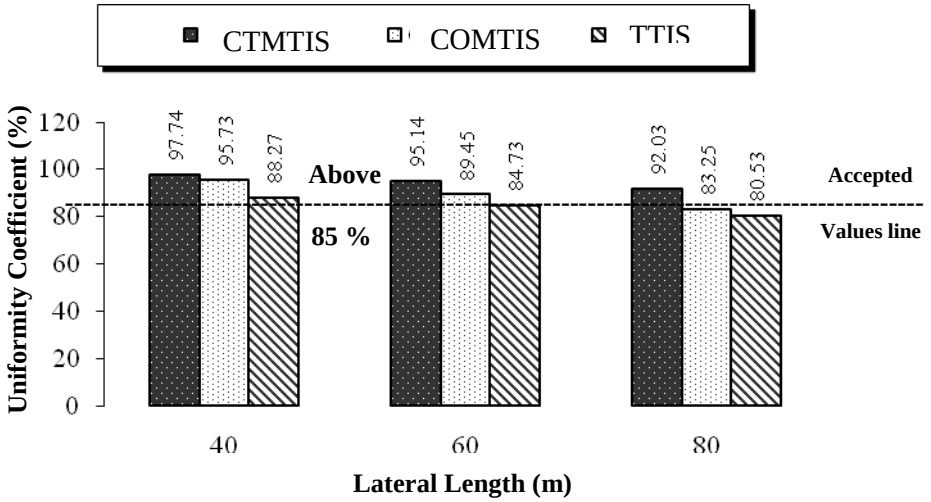

Fig. (6) Effect of lateral length on uniformity coefficient under closed circuit with one or two manifolds of trickle irrigation system (COMTIS) or (CTMTIS).

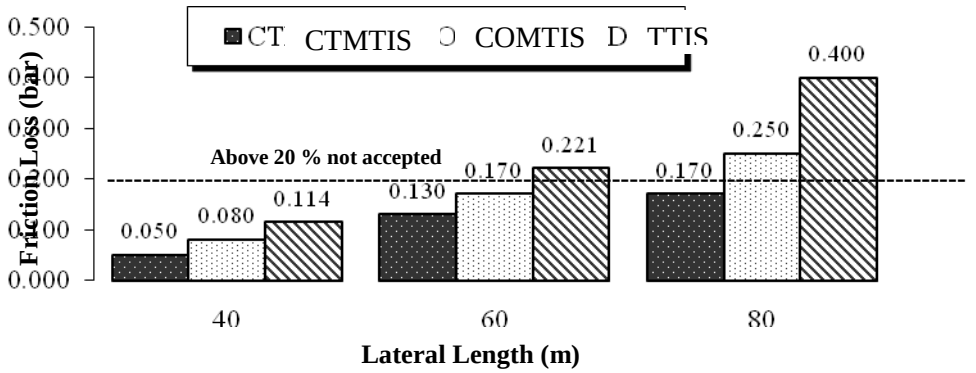

Fig. (7). Effect of lateral length on friction loss under closed circuits with one or two manifolds of trickle irrigation system (COMTIS) or (CTMTIS).

While with the change in the operating pressure where it's increased to 1.0 bar. When the length of lateral lines was 40m, the average value of the discharge in this case was 4.48 Lph under using CTMTIS While the average value of the discharge was 4.33 Lph with using the COMTIS method.The lateral lines at all cases of Control TTIS and lengths 60 and 80 m under used (CTMTIS, COMTIS), the average value of the discharge didn't reach the nominal value for this type of emitters (GR Built-in)

where the nominal value for this type of emitters is 4 Lph at the operating pressure is 1.0 bar as showing below the **Table (5).**

Table (5): Effect of operating pressures (bar) on discharges of the closed circuits.

Pressure (bar)	Discharge values (Lph)								
	Lateral lengths (m) of TIS			Lateral lengths (m) of CTMTIS			Lateral lengths (m) of COMTIS		
	40	60	80	40	60	80	40	60	80
0.2	1.35	1.26	0.89	2.00	2.15	2.30	1.66	1.48	1.11
0.4	1.50	1.39	1.01	2.60	2.35	2.63	2.00	1.84	1.53
0.6	1.84	1.58	1.15	3.87	3.35	3.67	2.88	2.31	2.25
0.8	2.25	1.82	1.37	4.38	3.74	3.74	4.20	3.40	3.37
1.0	2.93	2.18	1.73	4.48	3.94	3.86	4.33	3.57	3.68
1.2	3.10	2.49	1.98	4.52	4.02	3.94	4.41	3.69	3.71
1.4	3.24	2.98	2.23	4.59	4.11	4.15	4.53	3.78	3.80
1.6	3.47	3.35	2.52	4.64	4.27	4.31	4.64	3.96	3.92
1.8	3.65	3.49	2.88	4.70	4.33	4.43	4.70	4.15	4.13
2.0	3.84	3.55	3.32	4.76	4.48	4.56	4.76	4.35	4.26

*The shading areas are all discharge values at the nominal pressure (1.0 bar) and the discharge values above stander discharge value (4.0 lph)

*Standard value of GR dripper Built-in is (4.00 Lph at Operating pressure 1.00 bar)

*Values above (4.0 lph) when press. more 1.0 bar no accepted because need high energy.

CONCLUSION

It could be concluded that:

Irrigation systems at 40, 60, 80 m could be arranged according to emitters flow, the cumulative flow, and uniformity coefficient in the following ascending order: TTIS < COMTIS < CTMTIS. Irrigation systems at 40, 60, 80 m could be arranged according to friction losses of lateral lines in the following ascending order: CTMTIS < COMTIS < TTIS.

The increases percentage in uniformity coefficient under CTMTIS were (9.68; 10.94 and 12.49 %), while the increases percentage under COMTIS were (7.79; 5.27 and 3.26 %) at three lateral lengths 40, 60, and 80 m, respectively relative to TTIS. Was reached values higher than the standard value for the discharge of this emitters type, a 4 L/h at operating pressure 1.00 bar by using a closed irrigation systems at a low operating pressure 0.8 bar, giving an important indicator of energy saving operation using these modifications to the trickle irrigation system. Under using the CTMTIS and COMTIS when Lateral Length 40m we got on a 4.38, 4.20

L/h, respectively, Finally, observed data recommend that application CTMTIS when lateral length are 40, 60 and 80m, COMTIS when lateral length 40 and 60 m and TTIS when lateral length 40 due to an increase the emitters uniformity (above 85% UC) and low friction losses (less than 20%) in lateral lines, which led to constant pressure along the line sub-flow and balance at the end of the line such as the beginning.

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الملخص العربى

تطوير انتظامية إضافة المياه بين دوائر مغلقة لنظام الري بالتنقيط

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الهدف من هذا البحث هو تحديد انتظاميه الاضافه المثلى بين عدة تصميمات لدوائر مغلقة لنظام الري بالتنقيط. وقد تم قياس معدلات التدفق معمليا حيث تم اختبار نوعين من تصميمات هذه الدوائر المغلقة. النوع الأول دائرة مغلقه باستخدام خط مانيفولد واحد متصل (خط توزيع واحد) من نظام الري بالتنقيط (COMTIS). والنوع الثاني باستخدام خطين مانيفولد (خطين توزيع منفصلين) من نظام الري بالتنقيط (CTMTIS). وتم اخذ نظام الري بالتنقيط العادى (TTIS) للمقارنه (Control). استخدمت ثلاثة أطوال لخطوط الفرعيات (Laterals) هى ٤٠ ، ٦٠ ، و ٨٠ مترا تحت كل نوع من الدوائر المغلقه وتمت المقارنه بنظام التنقيط العادى. وقد اجريت التجارب بمعمل اختبارات الرى الحقلى، بمعهد بحوث الهندسة الزراعية ، مركز البحوث الزراعية ، وزارة الزراعة ، بالدقى ، القاهرة ، مصر خلال الفترة من يناير حتى مايو ٢٠٠٨. وكانت اهم النتائج كما يلي :

١- معدلات التدفق: حيث اختلفت قيم معدل التدفق عن بعضها في جميع الحالات، ففي حالة الدوائر المغلقة من النوع (COMTIS) كانت قيم معدلات التدفق ٤,٠٧ ، ٣,٥١ و ٣,٥٩ لتر / ساعة، أما في حالة النوع (CTMTIS) كانت ٤,١٨، ٣,٧٢ ، و ٣,٧١ لتر / ساعة، بينما في حالة نظام التنقيط العادي (TTIS) كانت ٣,٢١ ، ٢,٦ ، و ٢,١٦ لتر / ساعة تحت أطوال الخطوط الفرعية ٤٠، ٦٠، ٨٠ متر على الترتيب.

٢- معامل الانتظامية: تفاوتت قيم معامل الانتظامية من حيث نوع الدائره المغلق او طول الخط الفرعى على السواء وكانت الفروق معنويه فيما بينها، فعند استخدام دوائر مغلقه من النوع (COMTIS) كانت قيم معامل الانتظاميه ٩٥,٧٣ ، ٨٩,٤٥، و ٨٣,٢٥ %، وعند استخدام النوع (CTMTIS) كانت ٩٧,٧٤ ، ٩٥,١٤ ، و ٩٢,٠٣ %، بينما باستخدام النوع العادى (TTIS) كانت ٨٨,٢٧ ، ٨٤,٧٣ ، و ٨٠,٥٣ % تحت أطوال الخطوط الفرعية ٤٠، ٦٠، ٨٠ متر على الترتيب. وبناء على تلك النتائج فتكون التوصية باستخدام الدوائر الأكثر انتظاميه وهى فى حالة الدائره المغلقه من النوع (CTMTIS) وباستخدام خط فرعى بطول ٤٠، ٦٠، ٨٠ متر، وايضا فى حالة الدائره المغلقه من النوع (COMTIS) عند استخدام طول ٤٠، ٦٠ متر للخط الفرعى ، والطول ٤٠ متر فى حالة النظام التقليدى (TTIS). حيث كان السبب فى ذلك هو انه باستخدام هذه الدوائر انخفضت قيمت فاقد الاحتكاك (حيث تم تقديره) على طول الخطوط الفرعيه وعلى العكس فقد وجد انه زادت قيمته فى الحالات الاخرى من النظام التقليدى (TTIS) .

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