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TRICKLE IRRIGATION SYSTEMS IMPROVING BY USING BYPASS-TECHNIQUE

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ABSTRACT

It’s a fact that trickle irrigation systems became a major part for developing agriculture in Egypt for that, the aim of this research was reaching the highest values from irrigation systems management as the result of using bypass-technique, this new technique was done by installing microtubes at third last of trickle line. The laboratory experiments were carried out at the National Irrigation Laboratory of Agricultural Engineering Research Institute. The laterals were tested and calibrated under different operating pressure (0.50 - 0.75 – 1.00 -1.25 bar) for measuring emitter flow rates and determining emitter’s emission uniformity (EU) and its manufacture (CV). The following results were found:-

1- The emitters’ performance was determined by using relationship between emitter flow rates (L/h) and operating pressure (bar), data indicated that the emission uniformity (EU) was 95.68% (Excellent), at CV of 3.78% (Excellent) according to test standard (ASAE 1996) and actual flow rate was 14.08 l/h.
2- Installing microtubes., distance between emitters=0.5, 1.5 and 3 meters, present the following results respectively, where emission uniformity equal to 90.9%, 96.28% and 98.06 % (Excellent) in compare with traditional which in range of 89.34%, 95.52% and 96.03% respectively, emitters performance equation which was been in power relation in between average of flow rates (L/h) and pressure (bar).

It is recommended that bypass-technique gave a new advantage for trickle irrigation systems.

INTRODUCTION

Water uniformity distribution is related to the pressure variation along the lateral line. The pressure variation is largely affected by the friction losses and the lateral line inclination and related to the pressure variation along the lateral line. Myers and Bucks (1972) said that trickle irrigation systems do not apply water with perfect uniformity along the crop rows. Some of the variability is caused by manufacturing imperfection in the emitters, but the major problem was system design, in terms of the frictional loss in the direction of flow through the lateral pipe or tubing where emitters are attached. Keller and Karameli (1974) said that trickle irrigation is system for supplying filtered water on or into the soil. In trickle irrigation the objective is to provide each plant with a continuous readily available supply of soil moisture, which is sufficient to meet plant requirements. Trickle irrigation system consists of a water supply and pump followed by a network of mainlines and sub mains, laterals, and emitters. The mainline is the primary artery for delivery of water to the various irrigation zones. Within each zone there are usually a number of sub-mains units. Bypass-technique is a microtube also called spaghetti tubes are small bore polyethylene tubes, outer diameters was 4, 6 and 8mm. In this paper install microtubes in the last third of the trickle line for improving flow rates and emission uniformity along the trickle line. Goldberg, *et al.,* (1976) said that, these small bore tubes can be used as pressure compensating emitters in trickle irrigation system. Utilizing these flexible tubes as an alternative to modern emitters will reduce the risk of clogging significantly as they have simpler passages than those emitters. Khatri *et al.,* (1979) said when microtube is used as an emitter in a trickle system this small tube itself dissipates energy to flow a certain flow rate. The most important variable in its design is the calculation of energy losses due to friction at the inner wall of the tube and other minor components like entrance, exit, valves, bends, etc. These energy losses also represent the inlet pressure of the microtube since the outlet pressure is zero. Bhuiyan *et al.,* (1990) reported that nowadays microtubes are widely used as an extension for micro-sprinkler or micro-jet systems to increase the outlet pressure and therefore to cover larger areas. These small tubes are suitable for undulating and sloping lands where the pressure of the system varies considerably according to differences in elevation. Thus their lengths can be adjusted according to pressure heads to deliver a uniform flow rate. Hezarjaribi *et al.,* (2008) calculated the manufacturing variation coefficient, emitter flow rate coefficient and emitter flow rate exponent in order to establish flow sensitivity to pressure and compare manufacturers' specifications. Keshtgar (2012) said that trickle irrigation offers unique agronomical and economical advantages for the efficient use of water. The most water saving irrigation system.

The main objectives of this study were: Evaluating the emitter's performance for on-line source, flow rates (14 l/h). Installing four microtubes in the last third of the trickle line.

- Evaluating performance of emitters before installing bypass-technique (control).
- Evaluating performance of emitters after installing bypass-technique.

MATERIALS AND METHODS

Measurements were done according to ISO 9621 for evaluating emitter flow rates at National Irrigation Laboratory of Agricultural Engineering Research Institute (AEnRI), Dokki, Giza. The trickle irrigation systems test facility as shown in Fig. (1). under different operating pressures (0.50 - 0.75 - 1.00 -1.25 bar) according to (ASAE 1996) stander for:

a) Measuring emitter flow rates,
b) Determining emitter emission uniformity, EU, and
c) Determining microtube's emission uniformity.

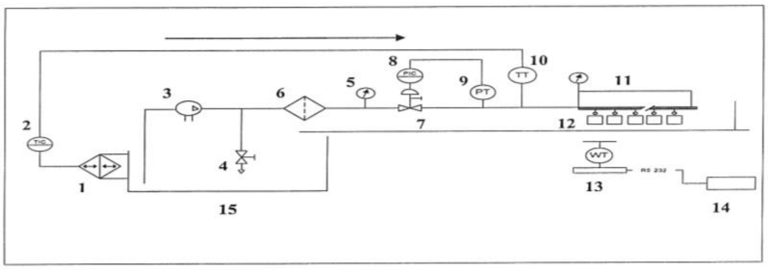


Fig. (1): Trickle irrigation test facility according to catalogue

1- Temperature conditioning unit;
2- Temperature regulator;
3- Multi-stage pumping unit;
4- Manual flow rate valve;
5- Direct reading pressure gauge;
6- Screen filter, 200 mesh;
7- Pressurized air regulating valve;
8- Pressure regulator;
9- Pressure transmitter;
10- Temperature transmitter;
11- Lines of pipes including tested emitters;
12- Water collectors for each emitter in test;
13- Weighing scale;
14- Personal computer; and;
15- Water tank, vol. of water storage500- 700 l.

The laterals lines form (LDPE) 16 mm outer diameter 1.3 mm thickness, four samples were collected from 400 meters length; each one was 30 meters length, including on-line emitters of 14 L/h. Distance between emitters (dbe) = 0.5, 1.5, 3.0 and 6.0 meters and microtubes with flow rates 150 L/h and 4 mm diameter to reach the research objectives. Where microtubes length (mil) = 1.0, 1.5, 3.5 and 1.5 meters respectively as shown in Fig. (3), installed at inverse emitter's direction and distance between emitter and microtube 5 cm.

Emitters flow rates:

There were measured at different operating pressures (0.50, 0.75, 1.00 and 1.25 bar). The emitter flow rates are usually characterized by the relationship between flow rates, pressure and an emitter flow rates exponent. The equation for emitter flow rates can be expressed as:

$$q = kp^x$$

Where: q = the emitter flow rates flow rate, (l/h);
K = a dimensionless constant of proportionality that characterizes each emitter;
p = Working pressure at the emitter, (bar), and;
x = a dimensionless emitter flow rate exponent that is characterizes by the flow regime. (Keller and Karmeli, 1974).

Emitter manufacture's coefficient of variations:

The manufacture's coefficient of variation "CV" indicator was calculated by measuring the flow rates from a sample of the new emitters according to (ASAE 1996 Standard), as follows:

$$CV = \left({}^{S}/_{q_{ave.}} \right) \times 100$$

Where, CV = manufacturer's coefficient of emitter variation, (%);
$q_{ave.}$ = Average flow rate, (l/h), and;
S = Standard deviation of emitter flow rates at a reference pressure head.

Emission uniformity (EU)

It's is used to indicate the emitter performance for emitters. It is also dependent on the manufacturing variation between emitters and the number of emitters per plant. To estimate the emission uniformity for a proposed design, the following formula was used (Keller and Karmeli, 1974);

$$EU,\% = \left(q_n / q_a\right) \times 100$$

Where: EU = the emission uniformity, (%);

q_n = The average of the lowest ¼ of the emitter flow rate, (l/h), and;

q_a = The average of all emitter flow rate, (l/h).

Experimental design and treatments:

Trickle line length of 30 m, distance between emitters of 0.5, 1.5, 3.0 and 6.0 meters respectively, as shown in Fig. (2).

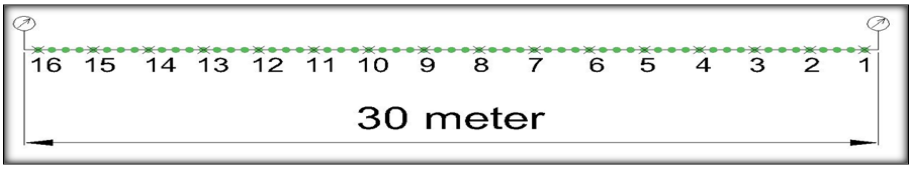


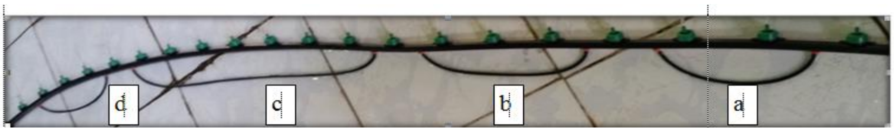
Fig. (2): Schematic shows trickle line before installing bypass-technique (control), distance between emitters= 0.5m

The experiments divided to:

First laboratory experiments: Evaluating the emitter's performance for on-line source, flow rates (14 l/h).

The second laboratory experiments:

- Evaluating performance of emitters before installing bypass-technique (control), as shown in Fig. (2).
- Evaluating performance of emitters after installing bypass-technique, as shown in Fig. (3). Where microtubes installed at inverse emitters direction and distance between emitter and microtube 5 cm.



a. Microtube length= 1.0 m
b. Microtube length= 1.5 m
c. Microtube length= 3.5 m
d. Microtube length= 1.5 m

Fig. (3): Proto-type for installation bypass-technique in the last third of the trickle irrigation line

RESULTS AND DISCUSSION

First laboratory experiments:

Evaluating the emitter's performance for on-line source, flow rates (14 l/h). As shown in Fig. (4), a relationship between emitter flow rates and operating pressure was indicated that once the operating pressure increases the emitter flow rates also increase. The emission uniformity (EU) was 95.65

% (Excellent) with CV of 3.78% (Excellent) according to **(ASAE, 1996)** and actual flow rate 14.08 L/h.

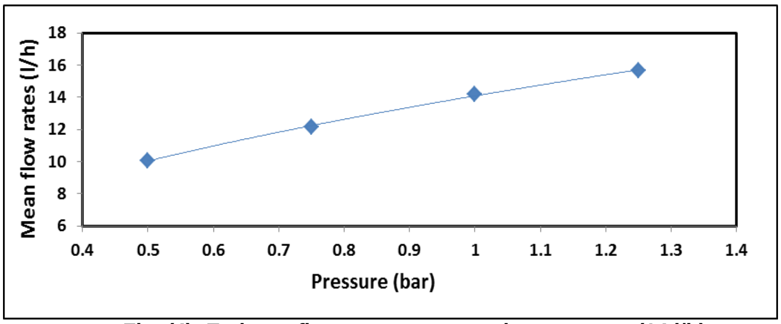


Fig. (4): Emitters flow rates vs. operating pressure (14 l/h)

The second laboratory experiments:

- **Evaluating performance of emitters before installing bypass-technique (control).**

Data in table (1) presented in Fig. (5), a relationship between emitter flow rates and operating pressure was obtained that once the operating pressure increases, the emitter flow rates also increase.

Table (1): Mean flow rates (control)

Pressure (bar)	Mean flow rates at different distance between emitters (l/h)			
	dbe= 0.5 m	dbe =1.5 m	dbe =3.0 m	dbe =6.0 m
1	11.1204	13.5064	13.7206	13.8708

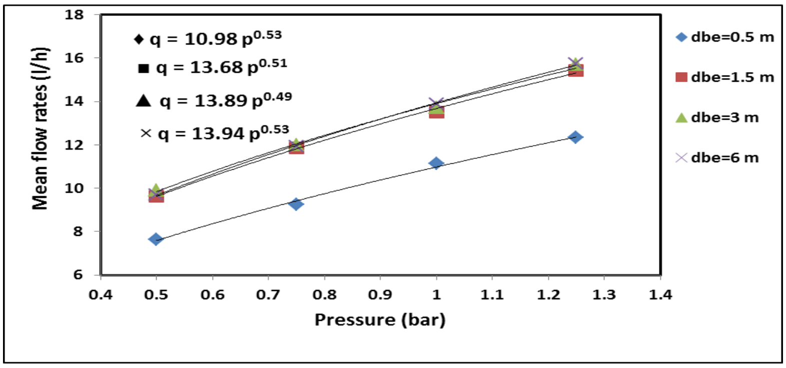


Fig. (5): Emitters flow rates vs. operating pressure before installing microtubes (control)

Evaluating performance of emitters after installing bypass-technique:

Data in table (2 and 3) presented in Fig. (6) Indicated that: All emitters' results performance equation which was in power relation in between average of flow rates (L/h) and pressure (bar). At distance between emitters = 0.5 m: According to ASAE (1996), Emission Uniformity (EU) after using microtubes = 90.9 % (Excellent) in compare with no use of microtubes = 89.34 % (Good) at operating pressure 1 bar. Emitter flow rates are increasing with percentage of 2.56 % in compare with the case of no use of using microtubes for nominal flow rates.

Table (2): Emitters performance at operating pressure 1 bar

Distance between emitters	Average of flow rates, (l/h)		Increasing percentage of flow rates after treatment,%
	After using bypass	Control	
0.5 meter	11.074	10.79	2.56 %
1.5 meter	14.386	14.17	1.53 %
3.0 meter	15.396	15.021	2.26 %

Table (3): Mean flow rates (after installing bypass-technique)

Pressure (bar)	Mean flow rates at different distance between emitters (l/h)			
	dbe = 0.5 m	dbe = 1.5 m	dbe = 3.0 m	dbe = 6.0 m
1	10.963	13.2612	13.904	13.4336

At distance between emitters = 1.5 m: EU after using microtubes = 96.28 % (Excellent) in compare with no use of microtubes = 95.52 % (Excellent) at operating pressure 1 bar. Emitter flow rates are increasing with percentage of 1.53 % in compare with the case of no use of using microtubes for nominal flow rates.

At distance between emitters = 3.0 m: EU after using microtubes = 98.06 % (Excellent) in compare with no use of microtubes = 96.03 % (Excellent) at operating pressure 1 bar. Emitter flow rates are increasing with percentage of 2.26 % in compare with the case of no use of using microtubes for nominal flow rates.

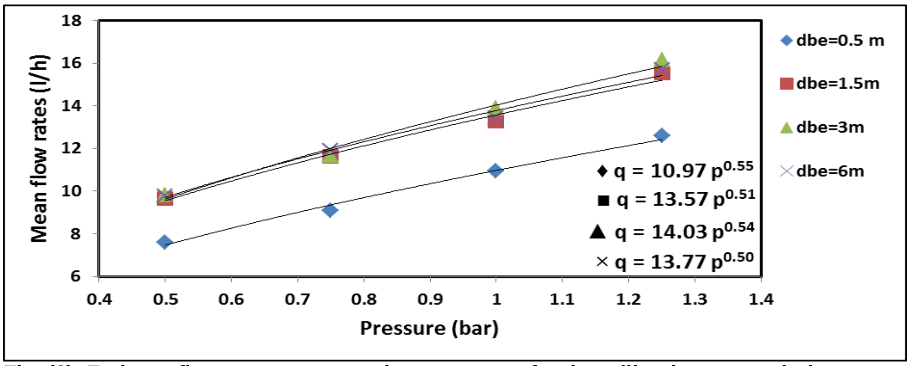


Fig. (6): Emitters flow rates vs. operating pressure after installing bypass-technique

At distance between emitters = 6.0 m: In case of using spacing between emitters lead to negative effect different in emitters performance through EU and emitters performance equation which was been in power relation in between average of flow rates (L/h) and pressure (bar).

From data presented, it may be concluded that negative effect in case of distance between emitters 6.0 m., but the most acceptable one was the system have distance between emitters 1.5 and 3.0 m.

CONCLUSIONS

The emitters performance was determined by using relationship between emitter flow rates (14 L/h nominal) and operating pressure (bar), the emission uniformity (EU) was 95.65 % (Excellent), at CV of 3.78% (Excellent) according to (ASAE, 1996) and actual flow rate 14.08 L/h.

The study presents a new design procedure for a trickle irrigation system, using variable length of microtubes, emission uniformity equal to 90.9%, 96.28% and 96.03% (Excellent) after installing four microtubes for distance between emitters= 0.5, 1.5 and 3.0 meters respectively, but when using bypass-technique at distance between emitters =6.0 meters, data represented that to negative effect different in emitters performance through EU and emitters performance equation which was in power relation in between average of flow rates (L/h) and pressure (bar).

The highest of Emission Uniformity (EU), average of flow rates (L/h)., and pressure (bar) when using four bypass-technique at distance between emitters 1.5 m and 3.0 m. From the last discussion it may be notes that at case of deb=1.5 m and 3.0 m the type of flow through line and velocity lead to get the low friction through the water line but in case of dbe=0.5 m the small distance between orifice lead to increase the friction loss which gave result in new technique.

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إستخدام المسار الموازي لتحسين نظم الري بالتنقيط

وفـــاء محمـــود عبـــد البـــاري إســـماعيل*،عبد الغنـــى محمـــد الجنـــدى*, خالد فران طاهر الباجوري*و وائل محمود مختار سلطان
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نظراً لمحدودية الموارد المائية وندرتها فقد أصبح ضرورياً العمل علي ترشيد استخدام المياه بإختيار طرق الري. فالري الموضعي من أكثر طرق الري ملائمة للمحاصيل البستانية (فاكهة- خضار- زينة)، ويحقق الري الموضعي فائدة بعيدة المدي في الإقتصاد في الموارد النادرة للمياه. ومن أحد نظم الري الموضعي هو نظام الري بالتنقيط السطحي. الري بالتنقيط السطحي يهتم بانتظامية توزيع المياه ولذلك فإنها ترتبط ارتباط وثيق بتغير الضغط علي طول الخطوط الفرعية، ومن مشاكل الري بالتنقيط السطحي هو هبوط الضغط وبالتالي التصرف في آخر الخط الفرعي.

الهدف من الدراسة:- إستخدام تقنية جديدة وهي تركيب المسار الموازي (ميكروتيوب) في الثلث الأخير من خط التنقيط. وذلك بهدف إدارة المياه وتحسين انتظامية توزيع النقاطات تحت نظم الرى بالتنقيط السطحي. وذلك حيث أن طول خط التنقيط = 30 متر، المسافة بين النقاطات = 0.5- 1.5- 3.0- 6.0 متر.

وفي هذا البحث تم التركيز علي هذه النقاط وذلك بإستخدام :

- نقاطات خارجية (14 لتر/ساعة).
- أنابيب " خراطيم " البولي إثيلين المنخفض الكثافة LDPE بقطر 16 مم وسمك 1.3 مم.
- خراطيم الميكروتيوب (الأسباجتي) بقطر 4 مم.

وقد أجريت التجارب المعملية في المعمل القومي لإختبار مكونات شبكات الري الحقلي بمعهد بحوث الهندسة الزراعية (AEnRI) الدقي- الجيزة، تحت ضغوط مختلفة (0.50- 0.75- 1.00- 1.25 بار) وتم قياس تصرف النقاطات واختلاف معامل التصنيع لها و انتظامية توزيعها.

وتم تقسيم البحث المعملي إلى :-

- التجربة المعملية الأولي: تقييم أداء النقاطات معملياً.
- التجربة المعملية الثانية: تركيب أربعة ميكروتيوب في الثلث الأخير علي خط التنقيط:
- تقييم أداء النقاطات قبل تركيب تقنية المسار الموازي.
- تقييم أداء النقاطات بعد تركيب تقنية المسار الموازي. تركب الميكروتيوب عكس اتجاه النقاطات والمسافة بين النقاط والميكروتيوب 5 سم.

النتائج والمناقشة

- التصرف الأسمي للنقاط الخارجي (14 لتر/ساعة) عند ضغط 1 بار: انتظامية التوزيع 95.68% (ممتازة)، وقيمة معامل اختلاف التصنيع 3.78% (ممتازة) طبقاً للجميعة الأمريكية للهندسة الزراعية، وأن التصرف الفعلي للنقاط 14.08 لتر/ساعة.
- بعد تركيب الميكروتيوب في الثلث الأخير من خط التنقيط: المسافة بين النقاطات = 0.5- 1.5- 3.0 متر
- كانت انتظامية توزيع النقاطات قبل تركيب تقنية المسار الموازي 89.34% (جيدة)- 95.52% - 96.03% (ممتازة) علي الترتيب. مقارنة بـ
- نتائج انتظامية التوزيع بعد تركيب تقنية المسار الموازي 90.9%- 96.28%- 98.06% (ممتازة) علي الترتيب.

* **التوصيات:-** مما سبق يتضح أن أفضل النتائج عندما كانت المسافة بين النقاطات 1.5- 3.0 متر حيث تم تحسين انتظامية التوزيع إلي 96.28%، 98.06%. و زيادة نسبة التصرف بعد تركيب المسار الموازي بـ 1.53%- 2.26% علي الترتيب.