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HYDRAULIC PERFORMANCE OF LOW PRESSURE DRIP IRRIGATION APPROPRIATE FOR SMALLHOLDINGS

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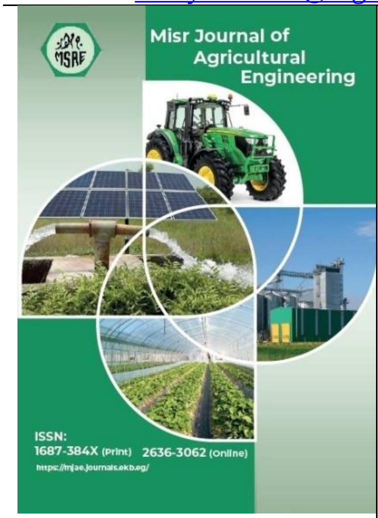


Keywords:
Drip irrigation; Hydraulic Performance; Smallholdings; Distribution uniformity.

ABSTRACT

The objective of this study was to analyze the hydraulic performance of low-pressure drip irrigation system on emitter discharge, coefficient of variation, emission uniformity and friction losses. Therefore, a laboratory and field experiments were conducted to assess the hydraulic performance of three drip lateral types [Gr (4 Lh^{-1}/30cm), Flat-tape (2 Lh^{-1}/30cm) and T-tape (10 Lh^{-1}/m)]. Discharge rates were measured at four different low- pressure heads (0.4, 0.6, 0.8 and 1 bar). Results show that the discharge of emitter is increased with increasing pressure and decreasing of lateral length, which implied that the combination between pressure and lateral length has a direct impact on the emitter's hydraulic performance of low- pressure drip irrigation systems. Consequently, the low operating pressure combined with short laterals resulted in the emitters produce the desired discharge with good performance parameters. As well as, high emission uniformity coefficient (90-97%) was observed at 30 and 40 m lengths for all lateral types and all operating pressure. For the types of Flat-tape and T-tape with a length of 50, 40, and 30m, all values of friction losses were acceptable at different operating pressures. The use of a low operating pressure less than1 bar indicated that it was an excellent operation condition in spite of that it was greater than the operating pressure in the range recommended by this dripper manufacturer. Furthermore, the use of low-pressure drip irrigation systems using the combination of low pressure and short laterals would reduce the energy requirements of operating smallholdings irrigation system.

INTRODUCTION

Irrigation systems in recent years have evolved radically as a result of the technological and scientific developments that accompanied various human activities and continuous activities to exploit natural resources in a more productive and efficient manner. Perhaps the issue of the availability of irrigation water is one of the problems faced by humans for agricultural purposes. One of the most difficult aspects of irrigation technology is to distribute water evenly and efficiently across a large area while utilizing the least amount of energy possible (**Perea et al., 2013; Ame, 2022**). Most vegetables' root systems are found in the top layer of the soil and required frequent irrigation, thus, a drip irrigation system is the most efficient and economical for irrigation for vegetable production (**Sharu, 2022**). In addition, for increasing importance in wet areas, large amounts of water are lost due to leakage and evaporation, which represents the loss of a valuable resource at a high cost. The drip irrigation method has the potential to eliminate water stress for crops even under severe water scarcity conditions, through a network of emitters and pipes to deliver the water directly to the root zone (**Narayanamoorthy et al., 2018**).

Therefore, it is necessary to improve irrigation systems and management technologies. Micro-irrigation refers to low-pressure irrigation systems that use drippers and small tube emitters to provide water on or beneath the soil surface (**Rashad, 2013**). These micro irrigation systems have been adopted because of the high potential benefits of high irrigation uniformity, water-saving performance, and energy efficiency (**Almeida et al., 2016; Lili et al., 2013; Li, 2020**). Drip irrigation is one of the most efficient micro-irrigation systems for applying small and consistent irrigation to crops, allowing for the regulated injection of chemicals and the application of frequent and light irrigation depths (**Onwuegbunam, 2020**). It provides water and nutrients directly to the plant’s root zone, in precise amounts and at the right times, ensuring that each plant receives exactly what it requires when it requires it for optimal growth (**Yurdem, et al., 2015**). For a drip irrigation system, the pressure and flow rate variations of the emitters along the laterals must be kept below acceptable limits to maintain water distribution uniformity at acceptable levels (**Bush et al., 2016; Sharu and Razak, 2020**). A new low-pressure emitter type was evaluated **(Mostafa and Thörmann, 2013**). The results were categorized as fair to excellent and considering water distribution and usage. The proper hydraulic design of lateral drip systems usually requires precise assessment of the total head loss represented by friction loss along the pipe and the emitter, and the local loss due to the emitter’s connection (**Martinez et al., 2022**). Local losses should be considered in any drip irrigation because the installation of large numbers of emitters along lateral pipes will affect the overall loss. Reliable methods to estimate local losses either based on kinetic load (**Celik, et al., 2015**) or on equivalent length (**Sarker et al. 2019; Chamba, et al., 2019**) have been reported in the literature. This study was undertaken with objective to evaluate the performance of drip irrigation laterals in both laboratory and field to ensure that the desired emitter discharge uniformity required for the system design is met, and to see whether the system could be operated efficiently under low-pressure.

MATERIALS AND METHODS

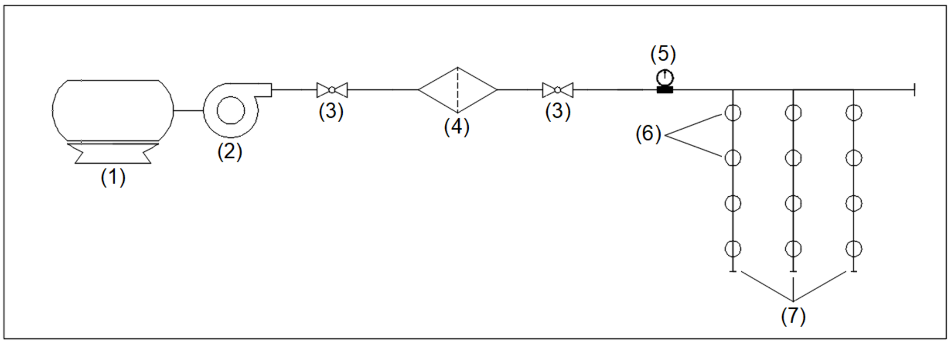
The research experiments were done in two stages, the laboratory and field experiment, to evaluate and compare the performance of tested emitter types on different laterals lengths at different operating pressures.

1. The laboratory experiment

Laboratory experiments were carried out at the National Irrigation Laboratory of the Agricultural Engineering Research Institute (AEnRI), ARC, MALR, Dokki, Giza before the field experiments. Three lateral lengths (50, 40, and 30 m) for three types of lateral lines (Gr 4 Lh^{-1}/30cm), Flat-tape (2 Lh^{-1}/30cm), and T-tape (10 Lh^{-1}/ m) were tested and evaluated under different operating pressures (0.4, 0.6, 0.8, and 1 bar) as low pressure.

Irrigation system components

A special unit has been created inside the laboratory to fit the lengths of the tested laterals, as shown in Fig. 1.



1. Water tank, 2. Pump, 3. Discharge valve, 4. Screen filter, 5. Pressure gauge, 6. Water collectors (measurement cans) and 7. Tested laterals

Fig. (1) Laboratory unit test

Tested laterals: Available lateral samples were collected from the local market (3 types) as shown in Table (1) and tested with different lengths (30, 40, and 50 m) and different low pressures (0.4, 0.6, 0.8, and 1 bar) to obtain the best emission with the best suitable length. Each lateral line type was tested individually to fit the laboratory space.

Table (1): Types of laterals used in tests and experiments in general

No	Type of lateral	Type of dripper	Flow rate (l/h)	Emitter spacing (cm)
1	Gr	Short dripper	4	30
2	Flat-tape	Flat dripper	2	30
3	T-tape	Flat dripper	10 L h^{-1} /m	10

Pressures were set at 0.4, 0.6, 0.8, and 1 bar, and the flow rates were taken and measured by weighting the water collected in plastic cans in a time of 15 minutes according to ISO 9621, as indicated by a stop watch, to minimize error associated with the starting and stopping of the individual runs and residual water in containers, and multiplying the weighting ($g.min^{-1}$) by 0.02 in order to turn the weight into volume (Lh^{-1}).

2. Field experiment

The field experiment was carried out in the farm of the College of Agriculture, Moshtohor, Benha University, Toukh District, Qalyubia Governorate, Egypt. This location represents clay soil conditions of the Nile delta region.

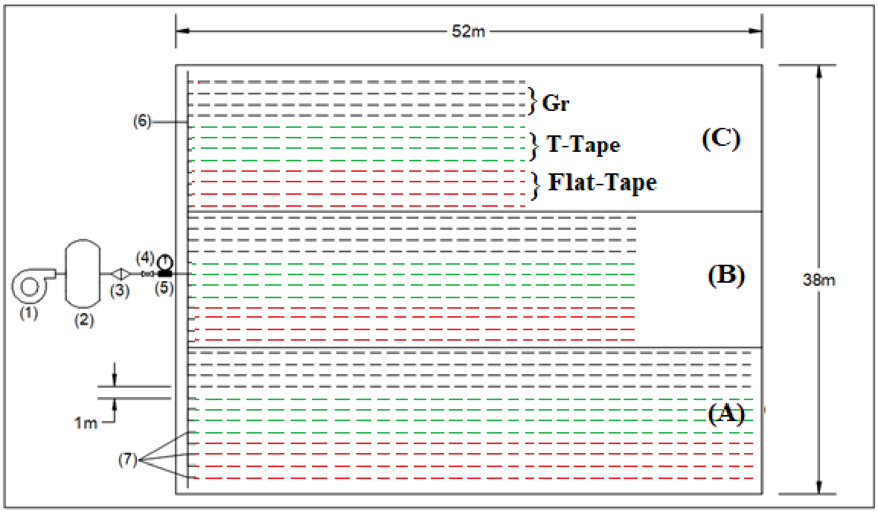
Experiment layout and treatments:

The experimental are was divided into three sections (A, B, and C) so that each section contained 3 types of laterals with 4 replicates for each type of lateral, and sections A, B, and C contained laterals with lengths of 50, 40, and 30, respectively. The components of the drip irrigation network and the layout of the experiment were as shown in Fig. (2).

Pressure – flow relationship: Emitter flow as a function of pressure can be expressed as the relationship between emitter discharge and operating pressure given by: **Keller and Karmeli (1975)** in the design of drip irrigation systems as follows:

$$q = kp^x \quad \textbf{(1)}$$

Where: q = emitter discharge (Lh^{-1}); k = a dimensionless constant of proportionality that characterizes each emitter; p = operating pressure at the emitter (bar); x = a dimensionless emitter discharge exponent that is characterized by the flow regime



1. Electrical centrifugal pump of 24 m^3/h discharge at 15 m pressure head with flow meter, 2. Sand filter, 3. Disk filter, 4. Ball valve, 5. Pressure gauge, 6. UPVC lines of 63 mm diameter were used to supply the water to the laterals, and 7. Drip lines (Laterals).

Fig. 2. Field experimental layout

.**The emitter flow variation (q_{var}):** It can be shown by comparing maximum and minimum emitter flows and was expressed as follows:

$$q_{var} = \frac{q_{max} - q_{min}}{q_{max}} \qquad (2)$$

Where: q_{var} is emitter flow variation (%), q_{max} is maximum emitter discharge (Lh^{-1}), and q_{min} is minimum emitter discharge (Lh^{-1}).

Emitter manufacture's coefficient of variations (C_v): The manufacture's coefficient of variation (C_v) was calculated according to **ASAE 2003** as follows:

$$C_v = {}^{S}/_{\overline{X}} \qquad (3)$$

Where: C_v = coefficient of variation (%); S = standard deviation of emitter discharge rates at a reference pressure head; $\overline{X}$ = average flow rate, (l/h).

Emission uniformity (EU): Emission uniformity shows the relationship between minimum and average emitter discharge. To estimate the emission uniformity for a proposed drip irrigation system design, the following equation was used **(Sharma, 2013).**

$$\mathrm{EU} = 100\left[1 - \frac{1.27\mathrm{CV}}{\sqrt{n}}\right]\left(\frac{q_{min}}{q_{av}}\right) \qquad (4)$$

Where: EU is emission uniformity, n is number of emitters per lateral for crop, and q_{avr} is average emitter discharge rate for the all emitter on the lateral (l/h).

Friction losses: The following Hazen – Williams's formula was used to calculate the head loss due to the friction:

$$H_f = 1.22 \times 10^{10} \times L \times (D)^{-4.8655} \times \left(\frac{Q}{C}\right)^{1.852} \times f \qquad (5)$$

Where: H_f = head loss due to friction (m); L = pipeline length (m); D = inside diameter (m); Q = pipeline discharge (l/s); C = friction coefficient for continuous pipe section; f = Reduction coefficient for multiple let out:

$$\boldsymbol{f} = \left(\frac{\mathbf{1}}{\mathbf{1+m}}\right) + \left(\frac{\mathbf{1}}{\mathbf{2n}}\right) + \left(\frac{\mathbf{1+m}}{\mathbf{6n^2}}\right) \qquad \textbf{(6)}$$

m = the velocity exponent; n = the number of outlets on the lateral.

The same methodology for measuring the hydraulic performance were done in the field as same as in lab.

RESULTS AND DISCUSSION

Pressure-flow relationship in lab and field.

Figs. 3, 4 and 5 illustrate and demonstrate the effect of the difference in lateral lengths on the relationship between pressure-flow as well as the regression equations in the laboratory and field for types of inline (Gr 4 Lh^{-1}), Flat-tape (2 Lh^{-1}), and T-tape (10 l/m.h). There was not a big difference between the laboratory results and the field results, but the results were very close. In all lateral types, the emitter discharge increased with increasing operating pressure, from 0.4 to 1 bar.

For the laboratory, the type of Gr (4 Lh^{-1}) the closest average discharge to the design discharge of the emitters was 3.77 Lh^{-1}at a pressure of 1 bar; 4.16 Lh^{-1} at a pressure of 1 bar; and 3.88 Lh^{-1} at a pressure of 0.8 bar for lengths 50, 40 and 30 m respectively.

For the field, the type of Gr (4 Lh^{-1}) the closest average discharge to the design discharge of the emitters was 3.7 Lh^{-1} at a pressure of 1 bar, 4.13 l/h at a pressure of 1 bar; and 3.87 Lh^{-1} at a pressure of 0.8 bar for lengths 50, 40 and 30 m respectively.

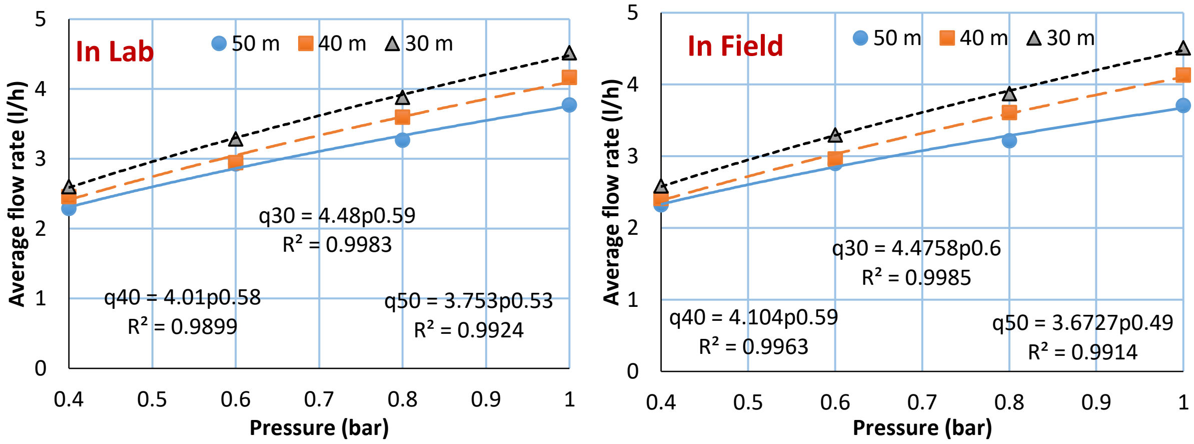


Fig. (3): Performance curves of pressure-flow for in-line (Gr 4 Lh^{-1}) at different lengths of laterals in the lab and field measurements

For the Flat-tape, in lab, the closest average discharge to the design discharge of the emitters was 1.97 Lh^{-1} at 0.6 bar, 2.08 Lh^{-1} at 0.8 bar and 2.27 l/h at 1 bar. With a length of 40 m, the closest average discharge to the design discharge of the emitters was 2.04 Lh^{-1}at a pressure of 0.6 bar. While with a length of 30 m, the closest average discharge was 1.88 Lh^{-1} at a pressure of 0.4 bar, and 2.1 Lh^{-1}at a pressure of 0.6 bar (Fig. 4).

For the field, the type of Flat-tape with a length of 50 m, the closest average discharge to the design discharge of the emitters was 1.92 Lh^{-1} at a pressure of 0.6 bar, 2.08 Lh^{-1} at 0.8 bar. With a length of 40 m, the closest average discharge to the design discharge of the emitters was 2.05 Lh^{-1} at a pressure, while with a length of 30 m, the closest average discharge was 1.87 Lh^{-1} at a pressure of 0.4 bar and 2.1 Lh^{-1} at a pressure of 0.6 bar.

For the type of T-tape, in lab with a length of 50 m, the closest average discharge to the design discharge of the emitters was 10.56 l/m.h at a pressure of 0.8, and 11.38 l/m.h at a pressure of 1 bar; with a length of 40 m, the closest average discharge was 10.38 l/m.h at a pressure of 0.6 bar and 11.13 l/m.h at a pressure of 0.8 bar. With a length of 30 m, the closest average discharge was 10.13 l/m.h at a pressure of 0.4 bar and 11 l/m.h at a pressure of 0.6 bar.

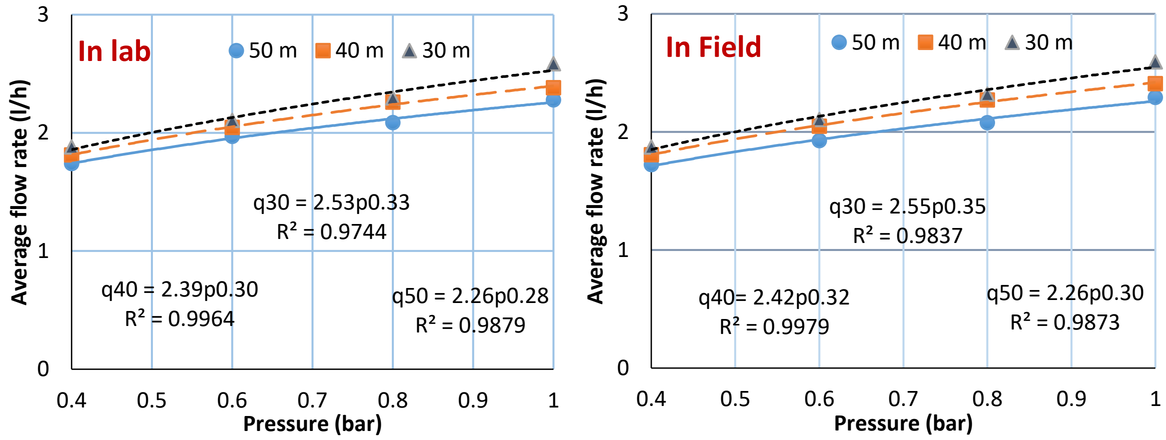


Fig. (4) Performance curves of pressure-flow for Flat-tape type (2 Lh^{-1}) at different lengths for laterals in lab and field measurements.

For the field, the T-tape (10 l/m.h) with a length of 50 m showed closest average discharge 10.27 l/m.h at a pressure of 0.8, and 11.14 l/m.h at a pressure of 1 bar. With length of 40 m, the closest average discharge was 10.11 and 11.25 l/m.h at 0.6 and 0.8 bar respectively, while 30 m lateral length showed an average discharge 9.91 and 10.65 l/m.h at 0.4 and 0.6 bar, respectively (Fig. 5).

Regression analysis was done to express the relationship of the average emitter discharge to the operating heads for each drip laterals in lab and field. Results are shown in Figs 3, 4 and 5. Results showed a strong relationship between the average emitter discharge and operating pressure head for both lab and field experiments for all lengths. It should be noted that the 30 m drip laterals emit a relatively higher emitter discharge than the longest for each operating pressure head. This may be attributed to the lower q_{avr}.

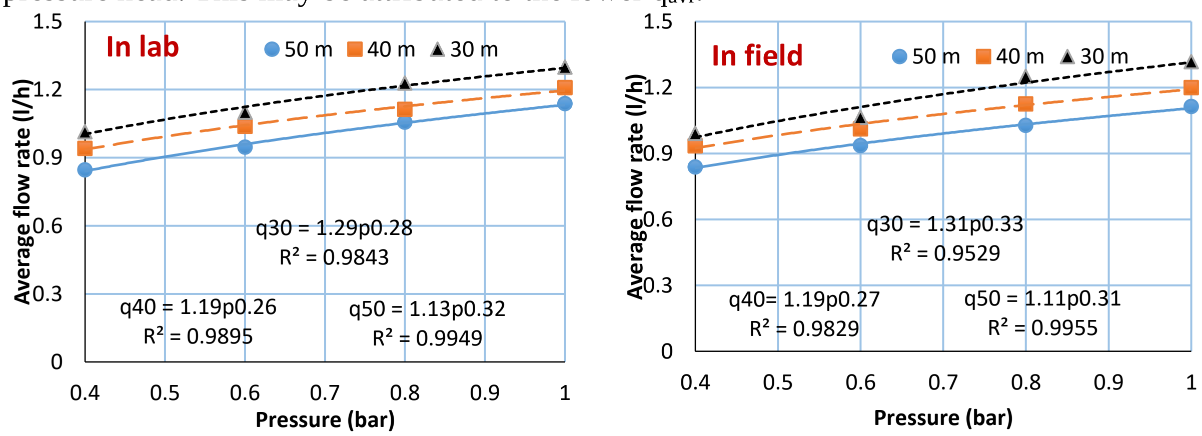


Fig. (5) Performance curves of pressure-flow for T-tape type (10 l/m.h) at different lengths for laterals in lab and field measurements.

Variation of average flow rate (q_{var})

Tables (2) and (3) show the effect of lateral length for all types of laterals on the variation of average flow rate q_{var} in the laboratory and the field at different operating pressures (0.4, 0.6, 0.8, and 1 bar). To investigate the emitter flow variation between these drip laterals, the average discharge and minimum discharge are calculated using the lab and field data. The results of flow variation can be used as a simple way to judge the water distribution uniformity from emitters. The general criteria for the emitter flow variation are (a) 10% or less—desirable; (b) 10 to 20%—acceptable; and (c) greater than 20%—not acceptable (**ASAE, 2006**).

Table (2): The effect of lateral length for all types on emitter flow variation

q_{var} (%)		Gr		Flat-tape		T-tape	
length of lateral	Pressure (bar)	Lab	Field	Lab	Field	Lab	Field
50 m	0.4	19.51	22.08	12.61	13.93	11.06	11.15
	0.6	21.52	19.88	13.47	12.60	10.66	13.40
	0.8	19.82	18.79	15.44	16.52	12.16	14.37
	1	19.23	17.04	12.34	15.78	7.23	16.48
40 m	0.4	8.27	5.41	11.60	12.76	8.25	6.53
	0.6	8.21	8.82	15.65	16.37	3.04	6.03
	0.8	12.65	15.93	14.48	15.80	9.82	8.99
	1	14.75	18.75	11.49	15.95	11.68	16.33
30 m	0.4	14.25	14.93	10.60	10.88	6.11	8.68
	0.6	14.45	19.57	9.52	11.28	4.76	8.38
	0.8	14.74	15.80	13.60	16.80	4.89	6.94
	1	15.12	16.03	8.48	10.90	6.23	7.73

For the type of Gr with a length of 50, 40, and 30 m, all values of q_{var} were acceptable at different operating pressures except at a length of 50 m at a pressure of 0.6 bar at lab and at a pressure of 0.4 bar at field. For the types of Flat-tape (2 Lh^{-1}) and T-tape (10 l/m.h) with a length of 50, 40, and 30 m at different operating pressures, all values of q_{var} were acceptable to desirable at both lab and field treatments.

All q_{var} values of Gr laterals were classified as unacceptable for 50m. q_{var} was increased by lateral length increasing for all lateral types under the lab and field treatments. q_{var} under lab were lower than field at the three lateral lengths for all lateral types. The four distinct operational pressures were classified in the same way as desirable. This means that increased operational pressure can result in a lot of variation. Consequently, the low operating pressure emitter discharge produces the desired result in emitter flow variance in this analysis.

Coefficient of variation (CV)

Table (3) shows the effect of lateral length for all types of laterals on the coefficient of variation in the laboratory and the field at different operating pressures (0.4, 0.6, 0.8, and 1 bar). The division into good, average, and unacceptable was done according to **ASAE (2006)**. For the laboratory, for the types of Gr, Flat-tape and T-tape with a length of 50, 40, and 30 m, all values of the coefficient of variation were good at different operating pressures.

According to the findings, it was observed with the increase in the drip system's operating pressure, the CV decreases as well, which implied that the pressure has a direct impact on the emitter's discharge volume. These findings also agree with previous studies (**Derbala, et al., 2023**). However, within the four different operational pressures, the classification was still excellent. As a result, the emitter discharge was used with low operating pressure for this analysis, which resulted in a good CV.

Table (3): The effect of lateral length for all types on the coefficient of variation (CV)

CV (%)		Gr (4 l/h)		Flat-tape		T-tape	
length of lateral	Pressure (bar)	Lab	Field	Lab	Field	Lab	Field
50 m	0.4	9.61	10.85	6.54	7.51	5.32	5.28
	0.6	9.84	9.39	6.38	5.91	5.13	6.70
	0.8	9.11	8.47	6.87	7.50	5.71	7.36
	1	8.92	8.15	6.64	8.09	3.25	8.16
40 m	0.4	3.78	2.41	5.65	5.82	4.25	3.22
	0.6	1.99	3.84	7.20	7.73	2.64	2.93
	0.8	6.63	8.36	6.63	7.15	4.70	4.69
	1	7.83	9.51	5.29	7.50	5.94	8.51
30 m	0.4	6.84	6.99	5.03	5.05	2.78	4.00
	0.6	6.75	9.29	4.09	4.98	2.15	4.55
	0.8	6.64	7.06	6.11	7.75	2.17	2.95
	1	6.78	7.33	3.70	4.85	2.05	2.93

Emission uniformity (Eu)

Based on the classifications showed in Table (4), the use of low operating pressure gave the best EU value for all lengths except Gr was less for 50 m length, this may be due to the higher emitter discharge than flat-tape and T-tape. The lower EU obtained from Gr treatment is attributed to higher Cv observed at 50m. These findings also agree with previous studies (**Awe and Ogedengbe, 2011**). EU values obtained are also comparable to those of **Manisha et al. (2015)** who studied the performance evaluation of conventional drip irrigation system with rate of 4 Lh^{-1}.

This result indicates that the higher and lower pressures are affected by the variation of discharge in each emitter. This finding is similar to the study conducted by **ASAE (2003)**, who found that the CV, and EU are classified as excellent but the q_{var} is classified as inacceptable. The qvar result obtained by **Pragna et al. (2017)** could be due to the type of emitter used.

Table (4): The effect of lateral length for all types on the Emission uniformity (Eu)

Eu (%)		Gr (4 l/h)		Flat-tape (2 l/h)		T-tape	
length of lateral	Pressure (bar)	Lab	Field	Lab	Field	Lab	Field
50 m	0.4	87.56	86.21	93.41	93.28	94.89	94.94
	0.6	89.98	89.89	91.54	92.39	95.03	94.32
	0.8	89.09	88.70	91.39	90.71	94.81	94.73
	1	89.09	89.79	93.15	91.64	96.98	91.24
40 m	0.4	96.14	96.82	94.43	93.36	96.14	96.97
	0.6	97.68	95.44	90.24	91.38	98.33	97.53
	0.8	96.01	94.55	90.70	90.75	94.62	95.93
	1	95.24	94.05	93.92	91.90	93.76	91.17
30 m	0.4	92.45	92.65	92.99	93.32	96.01	95.46
	0.6	91.28	90.69	94.88	94.70	96.91	95.77
	0.8	91.37	91.82	92.28	91.09	97.12	96.53
	1	90.62	92.13	95.69	94.54	97.37	96.65

The Effect of lateral length for all types on the Friction losses (H_f)

Table (5) shows the effect of lateral length for all types of laterals on the friction losses in the laboratory and the field at different operating pressures. All calculations were done theoretically by using the Hazen-Williams equation.

For the laboratory and the field, for the type of Gr with a length of 50 m, all values of H_f were acceptable at different operating pressures except at a pressure of 1 bar. All values of H_f were acceptable at different operating pressures for lengths of 40 and 30 m except at a pressure of 0.8 and 1 bar. For the types of Flat-tape and T-tape with a length of 50, 40, and 30m, all values of H_f were acceptable at different operating pressures.

The drip irrigation system's hydraulic performance analysis was assessed with four different operating pressures. The findings demonstrated that when running at a certain operating pressure, the drip irrigation system works well (**Sharu and Razak, 2020**). **Amound (1995)** noted that each applies to a well-planned drip irrigation system if the CV is at least 85% and the EU is higher than 90%.

Table (5): The effect of lateral length for all types on the Friction losses

Hf (m)		Gr (4 l/h)		Flat-tape (2 l/h)		T-tape	
length of lateral	Pressure (bar)	Lab	Field	Lab	Field	Lab	Field
50 m	0.4	1.00	1.02	0.60	0.59	0.15	0.15
	0.6	1.57	1.54	0.75	0.72	0.19	0.19
	0.8	1.93	1.87	0.84	0.83	0.23	0.22
	1	2.51	2.43	0.99	1.00	0.27	0.26
40 m	0.4	0.91	0.87	0.51	0.51	0.15	0.15
	0.6	1.27	1.28	0.64	0.65	0.18	0.17
	0.8	1.84	1.85	0.75	0.78	0.21	0.21
	1	2.42	2.38	0.86	0.87	0.24	0.24
30 m	0.4	0.76	0.75	0.41	0.41	0.13	0.12
	0.6	1.17	1.17	0.51	0.51	0.15	0.14
	0.8	1.59	1.58	0.60	0.61	0.18	0.19
	1	2.11	2.10	0.75	0.75	0.21	0.21

CONCLUSIONS

For hydraulic performance, from the results of different hydraulic parameters such as the emission uniformity (EU), and the coefficient of variation (CV), it could be seen that the drip irrigation system performs well and has met the ASAE standards. Hydraulic performance studies of drip irrigation systems help in determining the appropriate range of operating pressure, type of emitter, distance between emitter, and discharge of each emitter. If the discharge information for each emitter is known, the timing for irrigation can be determined based on the needs of the crop.

The results concluded that the use of low operating pressure compared to the minimum operating pressure proposed by the manufacturer could operate in excellent condition according to the hydraulic parameters evaluated. This shows that the choice of a 0.4 to 0.8 bar pressure procedure in this study was sufficient for obtaining an outstanding classification in the EU, and CV. For q_{var}, the result for 0.4 and 0.6 bar operating pressure gave desirable classification that was better than 1 bar pressure operations for studied lengths and lateral types. To put it another way, it is preferable to use less power rather than more power.

In conclusion, the results obtained from this study help in determining the desired irrigation capacity using an appropriate length. The hydraulic performance of the studied system shows that it is optimized by setting the operating pressure within the range of 0.4 to 0.8 m, with 30 and 40 m for Gr, T-tape and flat-tape.

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الأداء الهيدروليكي للري بالتنقيط منخفض الضغط مناسب للحيازات الصغيرة

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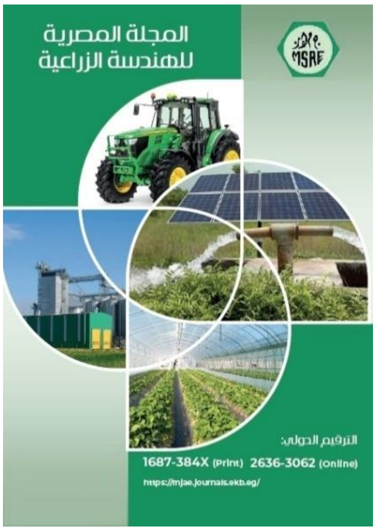

الكلمات المفتاحية:
الري بالتنقيط؛ الأداء الهيدروليكي؛ ري الحيازات الصغيرة؛ انتظامية التوزيع.

الملخص العربي

على الرغم من مميزات طريقة الري بالتنقيط في التحكم العالي في استخدام المياه، إلا أن الري بالتنقيط للحيازات الصغيرة يحتاج إلى تقييم أدائه الهيدروليكي في ظل ظروف التشغيل الحقلية، وخاصة ضغوط التشغيل المنخفضة واطوال خطوط التنقيط القصيرة. كان الهدف من هذه الدراسة هو تحليل الأداء الهيدروليكي لنظام الري بالتنقيط منخفض الضغط فيما يتعلق بتصريف النقاطات، ومعامل الاختلاف وانتظامية توزيع المياه وانتظامية البث او الانبعاث، وفواقد الاحتكاك الهيدروليكى. لذلك، تم إجراء تجارب معملية وميدانية لتقييم الأداء الهيدروليكي لثلاثة أنواع من خطوط التنقيط T-tape (10 Lh^{-1}/m) Flat-tape (2 Lh^{-1}/30cm) , Gr (4 Lh^{-1}/30cm). تم قياس معدلات التصرف عند أربعة ضغوط مختلفة (٠,٤، ٠,٦، ٠,٨ و١ بار). أظهرت النتائج أن تصريف النقاط يزداد مع زيادة الضغط وتناقص طول خط التنقيط الجانبي، مما يعني أن الجمع بين الضغط وطول خط التنقيط الجانبي له تأثير مباشر على الأداء الهيدروليكي للنقاطات في أنظمة الري بالتنقيط للحيازات الصغيرة ذات الضغط المنخفض. حيث وجد ان التشغيل على ضغط منخفض مع خطوط التنقيط الجانبية القصيرة ٣٠ و٤٠ متر ادى إلى ان النقاطات اعطت التصرفات المطلوبة بخصائص أداء جيدة. كذلك لوحظ ارتفاع معامل تجانس الانبعاث (٩٠-٩٧٪) عند أطوال ٣٠ و٤٠ متراً لجميع الأنواع خطوط التنقيط الجانبية ولجميع ضغوط التشغيل. بالنسبة لأنواع T-tape and Flat-tape بطول ٥٠، ٤٠، ٣٠ متر، كانت جميع قيم فقد الاحتكاك مقبولة عند ضغوط التشغيل المختلفة. يشير استخدام ضغط تشغيل منخفض أقل من ١ بار إلى أن حالة التشغيل كانت ممتازة على الرغم من أنه كان أكبر من ضغط التشغيل في النطاق الموصى به من قبل الشركة المصنعة للتنقيط.