PERFORMANCE EVALUATION OF DRIP IRRIGATION SYSTEM ACCORDING TO THE SUGGESTED STANDARDS

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ABSTRACT

A field experiment was conducted during autumn season 2017 at Al-Saqlawia, far about 50km north-west of Baghdad/Iraq, aimed to a periodic evaluation for drip irrigation system to obtain best values of the suggested standards. The experiment included two factors; first, emitters' discharge (d) at two levels using emitters with 4Lh^{-1} design discharge (d_4) and emitters with 8Lh^{-1} design discharge (d_8). While the second factor; operational pressure at three levels, first level, operational pressure 0.5 bar(P_1), second, operational pressure 0.7 bar(P_2), and the last, operational pressure 1.0 bar (P_3), the experiment was designed according to randomized complete block design. The results showed a decrease in values of both uniformity coefficient and emission uniformity, while the rate of actual discharge and variation ratios have been increased with the increase of operational pressure and for both discharge, where the reduction ratios at uniformity coefficient reached 3.02%, 4.25%, while at emission uniformity 6.52%, 7.18%, then actual discharge ratios increased about 10.75%, 20.25%, while the discharge variation ratios increased to reach 389.36%, 490.48%; while at depending an emitter 8Lh^{-1} actual discharge, the reduction ratios at uniformity coefficient reached 1.33%, 2.64%, then at emission uniformity, they reached 3.91%, 2.85%, while actual discharge ratios increased to reach 11.73%, 21.44%, then the increase ratios of discharge variation were about 122%, 199.22% when comparing above values with the effect of operational pressure mentioned previously.

Key words: Drip irrigation, Uniformity Coefficient, Emission Uniformity, Christiansen equation

تقييم أداء نظام الري بالتنقيط وفقاً للمعايير المقترحة

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المستخلص

نفذت تجربة حقلية خلال الفصل الخريفي لعام 2017 في منطقة الصقلاوية التي تبعد حوالي 50 كم شمال غرب بغداد / العراق، اجراء تقييم دوري لانظمة الري بالتنقيط لايجاد افضل القيم لمعايير التقويم المعتمدة، اشتملت الدراسة عاملان، هما ؛ تصريف المنقط (d) وبمستوّيين، الاول; منقطات ذوات تصريف تصميمي 4 لترسا$^{-1}$ (d_4)، أما الثاني; منقطات ذوات تصريف تصميمي 8 لترسا$^{-1}$ (d_8) والضغط التشغيلي (P) بثلاث مستويات; اولهما; ضغط تشغيلي 0.5 بار(P_1)، الثاني; الضغط التشغيلي 0.7 بار (P_2) والثالث 1.0 بار (P_3)، صممت التجربة وفقاً لتصميم القطاعات الكاملة العشوائية (RCBD)، بثلاث مكررات لكل معاملة .أظهرت النتائج انخفاضا في قيم معامل التناسق وتناسق الانبعاث، فيما ازداد معدل التصريف الفعلي ونسب التغاير في تصريف المنقطات بزيادة الضغط التشغيلي ولكلا التصريفين، إذ بلغت نسب الانخفاض في قيم معامل التناسق 3.02% و 4.24%، فيما كانت في قيم تناسق الانبعاث 6.52% و7.18% وازدادت نسب التصريف الفعلي بحدود 10.75% و20.25%، بينما ازدادت نسب التغاير في التصريف لتصل 389.36% و490.48%، عند مقارنة القيم المعتمدة أعلاه بتأثير الضغط التشغيلي 0.5 بار مع الضغطين التشغيليين 0.7 بار و1.0 بار، حسب الترتيب، عند اعتماد منقطات ذوات تصريف 4 لتر سا$^{-1}$. أما عند اعتماد منقطات ذوات تصريف 8 لتر سا$^{-1}$، بلغت نسب الانخفاض في قيم معامل التناسق 1.33% و2.64% وبلغت نحو 2.85% و3.91% لتناسق الانبعاث، فيما ازدادت نسب التصريف الفعلي لتصل 11.73% و21.44% وازدادت نسب التغاير في التصريف لتصل الى حدود 122% و199.22% عند مقارنة القييم اعلاه بتأثير الضغوط التشغيلية سالفة الذكر.

الكلمات المفتاحية: الري بالتنقيط، معامل التناسق، تناسق الانبعاث، معادلة كريستيانسين

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INTRODUCTION

Water is considered the first determining factor of agricultural production. And with the increase of its scarcity problems, it is become necessary to reconsider the traditional irrigation methods, with the aim of using modern systems and technologies in irrigation that achieve an increase in productivity of water volume unit by reducing the water gates during irrigation process, so water and its provision are considered the tasks and priorities of many researchers and specialists in this domain, that is the increase of food production per water unit is one of the most important challenges that confront the researchers especially in the arid and semi-arid regions whose limited water resources(15). Alamoud(2) indicated that this challenge will open the door to discovery of modern and economical technologies that helps to rationalize and provide water in the suitable quality and quantities. The same researcher above showed that to preserve the achievements of agricultural development, a serious program of scientific researches should be adopted which is interested in the transfer of modern technology and taking care to select, design, evaluate, and develop this technique of drip irrigation systems. As its management and maintenance is a priority in the rationalize of water for agricultural proposes. Drip irrigation is one of the main methods in field irrigation, and it's also a relativity modern method, which frequently gives or supplies water to or below the soil surface as a discrete drops or ling stream by small devices called "emitters" installed along the water supply line (5), and this requires a periodic evaluation for the standards of this system and depend these standards in the use of this system to irrigate field areas as plant type and soil nature. Rain Bird (14) indicated that the uniformity of water distribution is one of the important parameters to describe the emitters and design the drip irrigation system, and the operation of water uniformity for a particular areas starts with irrigation process and the perfusion uniformity may be expressed from 0 to 100%, and it's impossible to achieve a uniformity of 100%, so the same researcher indicated to uniformity values of water distribution as follows, less than 70% is weak and 70% to 90% is good and higher than 90% the uniformity perfusion is excellent, while according to(8) the uniformity coefficient is excellent if its value is greater than 90% and good if the value is between 80% and 90%, while it is weak from 60% to 80% and unacceptable if its value is less than 60%. Deba(10) showed that the uniformity of water distribution in drip irrigation system depends on the manufacturing difference of the emitters. the operational pressure, and length of the sub-line, To get best uniformity of irrigation water distribution in the field, being by efficient evaluation and design for the system. Al-Mehmdy (3) has got best value of uniformity coefficient of water distribution, where it was 96.77% and 96.21% at 50kps operational pressure using drip irrigation system carrying emitters type "Turbo" which have an actual discharge 3.94 and 7.88Lh^{-1}, the same researcher added that the increase of operational pressure increases the velocity of water in the tube as a result of reducing the friction with stability of the cross-section area and therefore increasing the discharge. Al-Obiedy (1) showed that emitter's discharge in the lateral lines increases by increasing the operational pressure and decreases by increasing length of the side tube, while Malooki(6) indicated that the values of uniformity coefficient decrease with the increase of operational pressure, where the values were 98.94%, 95.63%, and 94.66%, while the values of emission uniformity were 98.40%, 91.69%, and 90.87%, while the values of discharge variation were 5.37%, 26.23%, and31.65% at operational pressure 50, 70, and 100 kps respectively. This was attributed to the emitters used in the evaluation are designed to operate according to low operational pressures, and any increase in pressure may cause irregular outflow and water distribution, the same researcher above indicated that the best results that were obtain are by depending an operational pressure of 50 kps. Wu and Gitlin (11) classified the variation values in discharge (q_{var}), when they are less than or equal to 10, they are preferred when they are between 10% to 20%, they are acceptable, while they unacceptable if they exceed 20%. Al-Kateeb and Al-Shameri (4) showed that the variation ratios in emitter's discharge increase with increasing of pressure, then they have attributed that the emitters used in evaluating the system are basically designed to operate according to low operational pressures about 50 Kps or less. So this study aims to a periodic evaluation for the drip irrigation system to achieve best values of the depended standards through which the practical and scientific procedures are depended to rationalizing the water use and raising the value of the invested water unit.

MATERIALS AND METHODS

Experiment's site

A field experiment was conducted to study performance evaluation of drip irrigation system during autumn 2017 in Al-Saqlawia region far about 50 Km north-west Baghdad/Iraq, that is located on latitude 33̊ 24′ 57″north and longitude 43̊ 41′ 23″east.

Study factors and experimental design

1. Emitter discharge (d): In this study, the emitters type GR were used whose design discharge as follows:

a. Emitters whose design discharge 4 Lh^{-1} (d_4).

b. Emitters whose design discharge 8 Lh^{-1} (d_8).

2. Operational pressure, the following were selected:

a. Operational pressure of 0.5 bar (P_1).

b. Operational pressure of 0.7 bar (P_2).

c. Operational pressure of 1.0 bar (P_3).

The experiment was conducted according to randomized complete block design (RCBD) and for three repeaters, table 1 shows the symbols of treatment and its details.

Preparing the experiment land

An area of 768 m^2 (dimensions 32 m*24 m) was selected and plowed by the mold board, it was smoothed and settled then divided into three sectors where dimensions of each one of it (9 m*24 m) with leaving a guardian region which its dimension (2.5 m*24 m), there're 6 treatments in each sector, according to the study factors, dimensions of each terrace are (1.5 m*24 m)

Components of drip irrigation system and its install

1. Main tube with diameter 3″ and length 50m.

2. Filter with diameter 3″

3. End line lock with diameter 3″, (No.2).

4. Lateral lines carrying emitters type GR and the distance between emitters is 0.40 m, as following:

a. Lateral lines length 180 m carrying emitters whose discharge 4 Lh^{-1}.

b. Lateral lines length 180 m carrying emitters whose discharge 8 Lh^{-1}.

5. Plugs of end line and locks of start line whose diameter 16 mm with 18 for each. Figure 1 illustrates how to install a drip irrigation system and according to its components, and the treatments were distributed randomly according to the design depended in the experiment.

Relationship between emitter's discharge and operational pressure

Three operational pressures 0.5, 0.7, and 1.0 bar were selected to get best two actual discharges of the design discharges depended in the experiment, and they are (4,8)Lh^{-1} by

Table 1. Treatments symbol and details.

Treatment	Symbol	Details
T1	d_4P_1	Emitter whose design discharge 4Lh^{-1} at operational pressure 0.5 bar
T2	d_4P_2	Emitter whose design discharge 4Lh^{-1} at operational pressure 0.7 bar
T3	d_4P_3	Emitter whose design discharge 4Lh^{-1} at operational pressure 1.0 bar
T4	d_8P_1	Emitter whose design discharge 8Lh^{-1} at operational pressure 0.5 bar
T5	d_8P_2	Emitter whose design discharge 8Lh^{-1} at operational pressure 0.7 bar
T6	d_8P_3	Emitter whose design discharge 8Lh^{-1} at operational pressure 1.0 bar

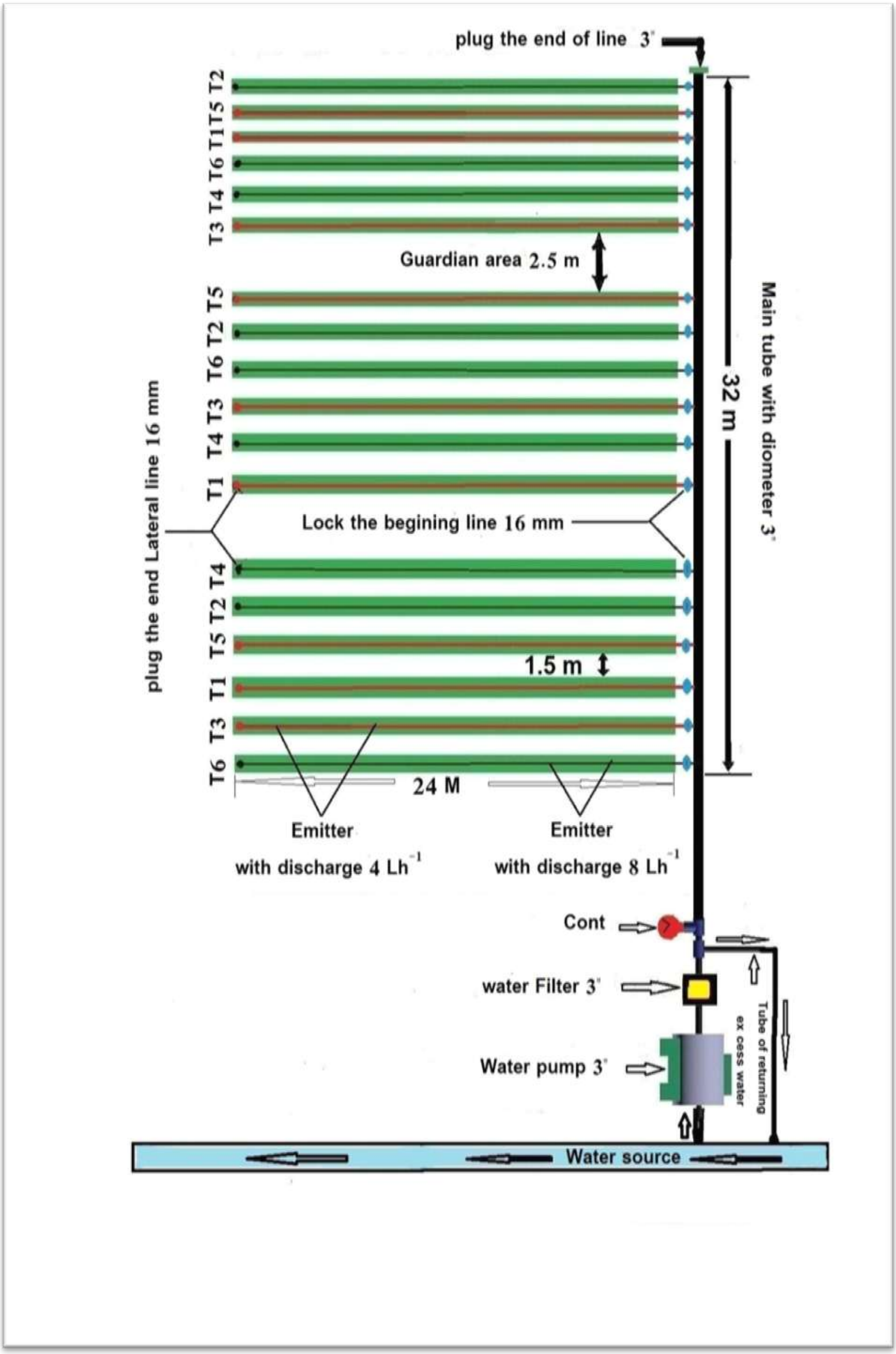

Fig. 1. Field experiment scheme

controlling the rotational velocity of the engine(rpm), reading the pressure on the meter at the beginning of installing the main tube to the lateral lines and the tube of returning the excess water to the source. This was done by applying the volumetric method when time is constant (0.25 h), and knowing the volume of water reaching the water collection cans scattered below the emitters, using the equation mentioned by (5), and as following:

$$q = \frac{\mathbf{v}}{\mathbf{t}} \dots\dots\dots\dots\dots (\mathbf{1})$$

Where: q = emitter's discharge (Lh^{-1}).

V = volume of water received in the cans (L).

t = operating time (h).

Tables 2 , 3 show the volumes of water received to the cans and actual discharge for each emitter according to the selected operational pressure. Uniformity coefficient was calculated using equation of "Christiansen" (12) and mentioned in (7), and as follows:

$$\boldsymbol{Uc} = \left(\mathbf{1} - \frac{\sum|\boldsymbol{xi}|}{\boldsymbol{M} * \boldsymbol{n}}\right) \dots\dots\dots\dots\dots (\mathbf{2})$$

Where:

Uc = Uniformity coefficient (%).

$\sum x\ i$= Total absolute deviations by the overall discharge rate (Lh^{-1}).

M = Overall discharge average of the emitters (Lh^{-1}).

n = Number of emitters

Then the variation ratio in the emitter's discharge was calculated according to the equation mentioned in (9),as following:

$$q_{var} = \frac{qmax - qmin}{qmax} * 100 \dots\dots\dots\dots\dots (3)$$

Where :

q_{var}=variation ratio of emitter's discharge(%)

maximum discharge of emitters (Lh^{-1}) . q_{max}

q_{min} = minimum discharge of emitters (Lh^{-1}).

while emission uniformity was calculated according to (3), the following equation :

$$Eu = \frac{q_{25\%}}{q} * 100 \dots\dots\dots\dots\dots\dots (4)$$

That is :

Eu = Emission Uniformity (%)

$q_{25\%}$ =discharge rate of the lowest quarter (Lh^{-1}) .

q =overall discharge rate of the emitters(Lh^{-1})

RESULTS AND DISCUSSIONS

Actual discharge of emitters: Figure2 illustrates that the actual discharges of emitters is directly proportional to the operational pressure, where actual discharge rates reached 4.00, 4.44, and 4.81 Lh^{-1} for the emitter whose design discharge 4 Lh^{-1}, while they reached 7.93, 8.6, and 9.63 Lh^{-1} for the emitter whose design discharge 8 Lh^{-1} at the operational pressures 0.5, 0.7, and 1.0 bar respectively. And the increase percentage reached about 10.75% and 20.25% when comparing the values of the actual discharge at the operational pressure 0.5 bar with the two operational pressures 0.7 and 1.0 bar respectively, by depending a design discharge 4 Lh^{-1}, while the increase percentage when depending a design discharge 8 Lh^{-1} reached 11.73% and 21.44% respectively. Then the increase of values in the actual discharge with the effect of operational pressure and for both emitter's discharge was significant according to the values of lowest significant difference (L.S.D). Increasing the operational pressure increases the speed of molecules inside the side tube section and therefore the friction decreases with stability of the cross-section area of this tube, and that's considered a reason of the increase of discharge, this is consistent with what mentioned by Al-Obiedy(1) and Al-Mehmdy(3) who indicated that the discharge in lateral lines increases by the increase of operational pressure due to the increase of water flow inside the tube, and reducing the friction and the discharge decreases by the increase of the lateral lines.

Table 2. Water Volumes Received in Collection Cans and Emitters' Discharges at Different Operational Pressures with Time 0.25 h Using Emitters whose Actual Discharges 4 Lh^{-1}

Emit. No.	0.5 Bar		0.7 Bar		1.0 Bar		Emit. No.	0.5 Bar		0.7 Bar		1.0 Bar	
	Water Vol. (L)	Emitter disch. (Lh^{-1})	Water Vol. (L)	Emitter disch. (Lh^{1})	Water Vol. (L)	Emitter disch. (Lh^{1})		Water Vol. (L)	Emitter disch. (Lh^{-1})	Water Vol. (L)	Emitter disch. (Lh^{-1})	water Vol. (L)	Emitter disch. (Lh^{-1})
1	1.025	4.10	1.140	4.56	1.390	5.56	25	1.000	4.00	1.130	4.52	1.190	4.76
2	1.025	4.10	1.100	4.40	1.370	5.48	26	1.000	4.00	1.130	4.52	1.190	4.76
3	1.000	4.00	1.180	4.72	1.340	5.36	27	1.000	4.00	1.130	4.52	1.190	4.76
4	1.000	4.00	1.120	4.48	1.300	5.20	28	1.005	4.02	1.100	4.40	1.190	4.76
5	1.015	4.06	1.140	4.56	1.300	5.20	29	1.000	4.00	1.200	4.80	1.190	4.76
6	1.010	4.04	0.900	3.60	1.290	5.16	30	1.000	4.00	1.140	4.56	1.185	4.74
7	1.025	4.10	0.940	3.76	1.290	5.16	31	1.000	4.00	0.950	3.80	1.185	4.74
8	1.020	4.08	1.110	4.44	1.280	5.12	32	1.005	4.02	1.170	4.68	1.180	4.72
9	1.000	4.00	1.220	4.88	1.280	5.12	33	1.000	4.00	1.100	4.40	1.180	4.72
10	1.010	4.04	1.140	4.56	1.275	5.10	34	1.000	4.00	1.180	4.72	1.180	4.72
11	1.010	4.04	1.120	4.48	1.270	5.08	35	0.995	3.98	1.180	4.72	1.180	4.72
12	1.010	4.04	1.100	4.40	1.250	5.00	36	0.985	3.94	1.060	4.24	1.170	4.68
13	1.005	4.02	1.110	4.44	1.250	5.00	37	0.980	3.92	1.050	4.20	1.170	4.68
14	1.000	4.00	1.130	4.52	1.250	5.00	38	0.990	3.96	1.050	4.20	1.150	4.60
15	1.000	4.00	1.140	4.56	1.250	5.00	39	0.970	3.88	1.050	4.20	1.150	4.60
16	1.010	4.04	1.180	4.72	1.245	4.98	40	0.975	3.90	1.060	4.24	1.150	4.60
17	1.020	4.08	1.200	4.80	1.240	4.96	41	0.970	3.88	1.130	4.52	1.140	4.56
18	1.025	4.10	1.120	4.48	1.240	4.96	42	0,980	3.92	1.110	4.44	1.130	4.52
19	1.000	4.00	1.100	4.40	1.230	4.92	43	0.990	3.96	1.200	4.80	1.120	4.48
20	1.010	4.04	1.100	4.40	1.230	4.92	44	1.000	4.00	1.140	4.56	1.100	4.40
21	1.005	4.02	1.140	4.56	1.220	4.88	45	0.980	3.92	1.050	4.20	1.050	4.20
22	1.005	4.02	1.110	4.44	1.210	4.84	46	0.970	3.88	1.030	4.12	1.000	4.00
23	1.000	4.02	1.160	4.64	1.200	4.80	47	0.975	3.90	1.050	4.20	1.000	4.00
24	1.000	4.02	1.140	4.56	1.200	4.80	48	0.975	3.90	1.000	4.00	0.950	3.80

Table 3. Water Volumes Received in Collection Cans and Emitters' Discharges at Different Operational Pressures with Time 0.25 h Using Emitters whose Actual Discharges 8 Lh^{-1}

Emit. No.	0.5 Bar		0.7 Bar		1.0 Bar		Emit. No.	0.5 Bar		0.7 Bar		1.0 Bar	
	Water volume (L)	Emitter disch. (Lh^{-1})	Water Vol. (L)	Emitter disch. (Lh^{-1})	Water vol. (L)	Emitter disch. (Lh^{-1})		Water Vol. (L)	Emitter disch. (Lh^{-1})	water Vol. (L)	Emitter disch. (Lh^{-1})	Water Vol. (L)	Emitter disch. (Lh^{-1})
1	2.080	8.320	2.420	9.680	2.780	11.120	25	2.000	8.000	2.250	9.000	2.390	9.560
2	2.080	8.320	2.400	9.600	2.750	11.000	26	2.000	8.000	2.250	9.000	2.390	9.560
3	2.080	8.320	2.400	9.600	2.690	10.760	27	2.000	8.000	2.220	8.880	2.390	9.560
4	2.080	8.320	2.400	9.600	2.620	10.480	28	2.000	8.000	2.220	8.880	2.390	9.560
5	2.050	8.200	2.350	9.400	2.620	10.480	29	2.000	8.000	2.220	8.880	2.390	9.560
6	2.050	8.200	2.350	9.400	2.570	10.280	30	2.000	8.000	2.220	8.880	2.370	9.480
7	2.050	8.200	2.350	9.400	2.570	10.280	31	2.000	8.000	2.220	8.880	2.370	9.480
8	2.048	8.192	2.340	9.360	2.550	10.200	32	2.000	8.000	2.220	8.880	2.360	9.440
9	2.046	8.184	2.300	9.200	2.550	10.200	33	2.000	8.000	2.220	8.880	2.360	9.440
10	2.040	8.160	2.280	9.120	2.540	10.160	34	2.000	8.000	2.220	8.880	2.360	9.440
11	2.028	8.112	2.270	9.080	2.520	10.080	35	2.000	8.000	2.220	8.880	2.360	9.400
12	2.020	8.080	2.270	9.080	2.520	10.080	36	1.980	7.920	2.220	8.880	2.340	9.360
13	2.020	8.080	2.270	9.080	2.520	10.080	37	1.980	7.920	2.140	8.560	2.340	9.360
14	2.020	8.080	2.270	9.080	2.520	10.080	38	1.978	7.912	2.140	8.560	2.330	9.320
15	2.010	8.040	2.270	9.080	2.520	10.080	39	1.870	7.480	2.100	8.400	2.320	9.280
16	2.010	8.040	2.270	9.080	2.500	10.000	40	1.860	7.440	2.100	8.400	2.320	9.280
17	2.010	8.040	2.270	9.080	2.480	9.920	41	1.850	7.400	2.100	8.400	2.320	9.280
18	2.010	8.040	2.260	9.040	2.480	9.920	42	1.850	7.400	2.100	8.400	2.250	9.000
19	2.010	8.040	2.250	9.000	2.460	9.840	43	1.850	7.400	2.100	8.400	2.220	8.880
20	2.010	8.040	2.250	9.000	2.460	9.840	44	1.850	7.400	2.100	8.400	2.200	8.800
21	2.008	8.032	2.250	9.000	2.450	9.800	45	1.850	7.400	2.060	8.240	2.100	8.400
22	2.000	8.000	2.250	9.000	2.430	9.720	46	1.850	7.400	1.840	7.360	2.100	8.000
23	2.000	8.000	2.250	9.000	2.410	9.640	47	1.850	7.400	1.820	7.280	2.100	8.000
24	2.000	8.000	2.250	9.000	2.410	9.640	48	1.840	7.360	1.800	7.200	1.820	7.280

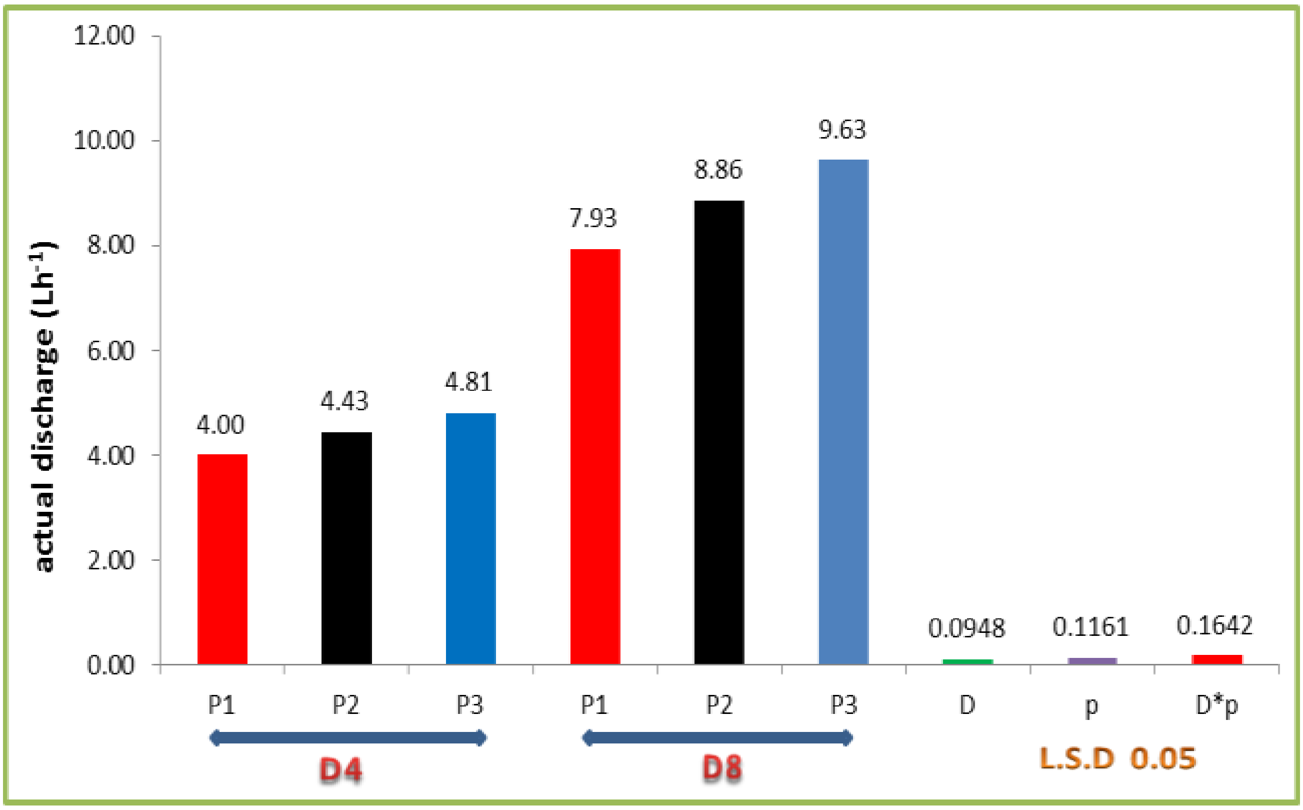

Fig.2.Effect of design emitter discharge and operational pressure in the values of actual discharge

Uniformity coefficient

Figure 3 illustrates that the uniformity coefficient is inversely proportional to the operational pressure when depending emitters type GR whose actual discharge 4 and 8 Lh^{-1} , where it has reached 98.85%, 95.86%, and 94.65% when increasing the operational pressure from 0.5 bar to 0.7 bar and 1.0 bar by depending emitters whose emitter's discharge 4 Lh^{-1} respectively. And the decrease percentage has reached 3.02% and 4.25% when comparing the value of uniformity coefficient at the operational pressure 0.5 bar with the value of uniformity coefficient for the two operational pressures 0.7 bar and 1.0 bar respectively, while values of the uniformity coefficient when depending emitters whose actual discharge 8 Lh^{-1} have reached 97.17%, 95.88%, and 94.60% for the operational pressures 0.5 bar, 0.7 bar , and 1.0 bar respectively, and for a decreasepercentages about 1.33% and 2.64% when comparing the value of uniformity coefficient at 0.5 bar operational pressure with the values of uniformity coefficient of the two operational pressures previously mentioned, respectively. And the values of L.S.D at level 0.05 showed a significant decrease, by the effect of study factors "discharge and operational pressure" and the interference between them. And that may be due to the increase of operational pressure causing irregular water outflow and therefore leads to irregular water distribution, and this is consistent with what mentioned by Al-Mehmdy (3) that the best value of uniformity coefficient was obtained at the operational pressure 0.5 bar, and this also agrees with what mentioned by Malooki (6) that the emitters used in the evaluation process were deigned to operate according to low operational conditions, and that the operational pressure caused an irregular outflow and distribution of water.

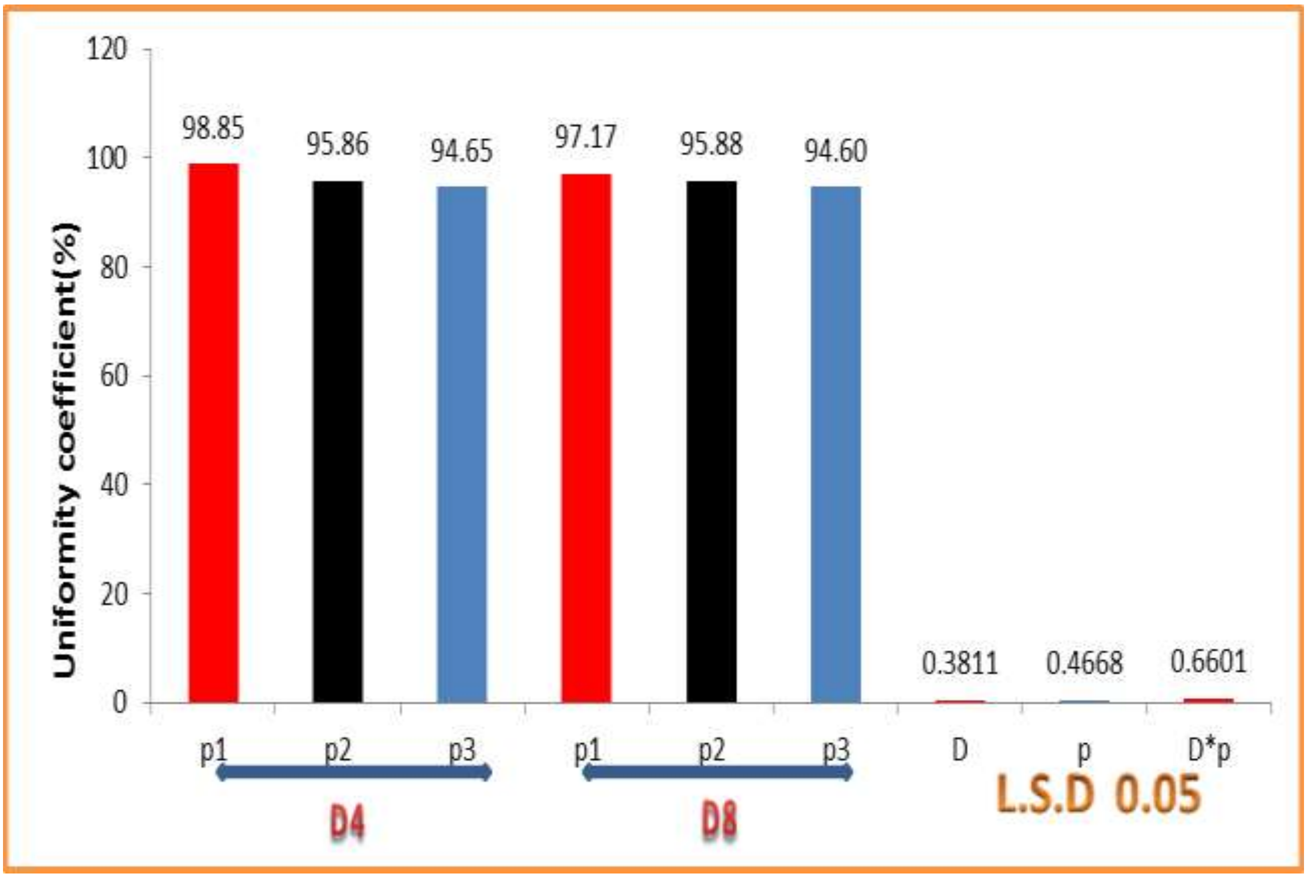

Fig.3.Effect of emitter's discharge and operational pressure in the values of uniformity coefficient

Variation percentage of emitter's discharge

Figure 4 illustrates that the variation percentage are directly proportional to the operational pressure when depending emitters type GR whose discharge 4 and 8 Lh^{-1} , where it has reached the values 5.36%, 26.23% and 31.65% by increasing the operational pressure from 0.5 bar to 0.7 bar and 1.0 bar when depending emitters whose actual discharge 4 Lh^{-1}, respectively, and the increase percentage in the values of discharge variation have reached 389.36% and 490.48% when comparing the value of discharge variation at operational pressure 0.5 bar with the values of the discharge variation for the two operational pressures 0.7 bar and 1.0 bar, respectively. while the values of discharge variation have reached 41.54%, 25.62%, and 34.53% when depending emitters whose actual discharge 8 Lh^{-1} at the operational pressure 0.5 bar, 0.7 bar and 1.0 bar, respectively, and with decrease values about 122% and 199.22% when comparing the value of discharge variation at the operational pressure 0.5 bar with the value of discharge variation of the two operational pressure 0.7 bar and 1.0 bar, respectively. When the values of lowest significant difference at level 0.05 showed a significant differences in the decrease values of discharge variation by the effect of study factors and the interferences between them. This is due to the increase in velocity of water flow inside the lateral drip tubes and therefore reducing the friction effect between the flowing water molecules, which was a reason in the raise in values of discharge variation as well as the raise of actual discharge for both emitter's discharges by increase of operational pressure, and this is consistent with what mentioned by Al-Kateeb and Al-Shameri (4) that the variation percentage increases by the increase of operational pressure, then they attributed this that the emitters used to evaluate the system were basically designed to operate according to low operational pressures (about 50 kps or less).

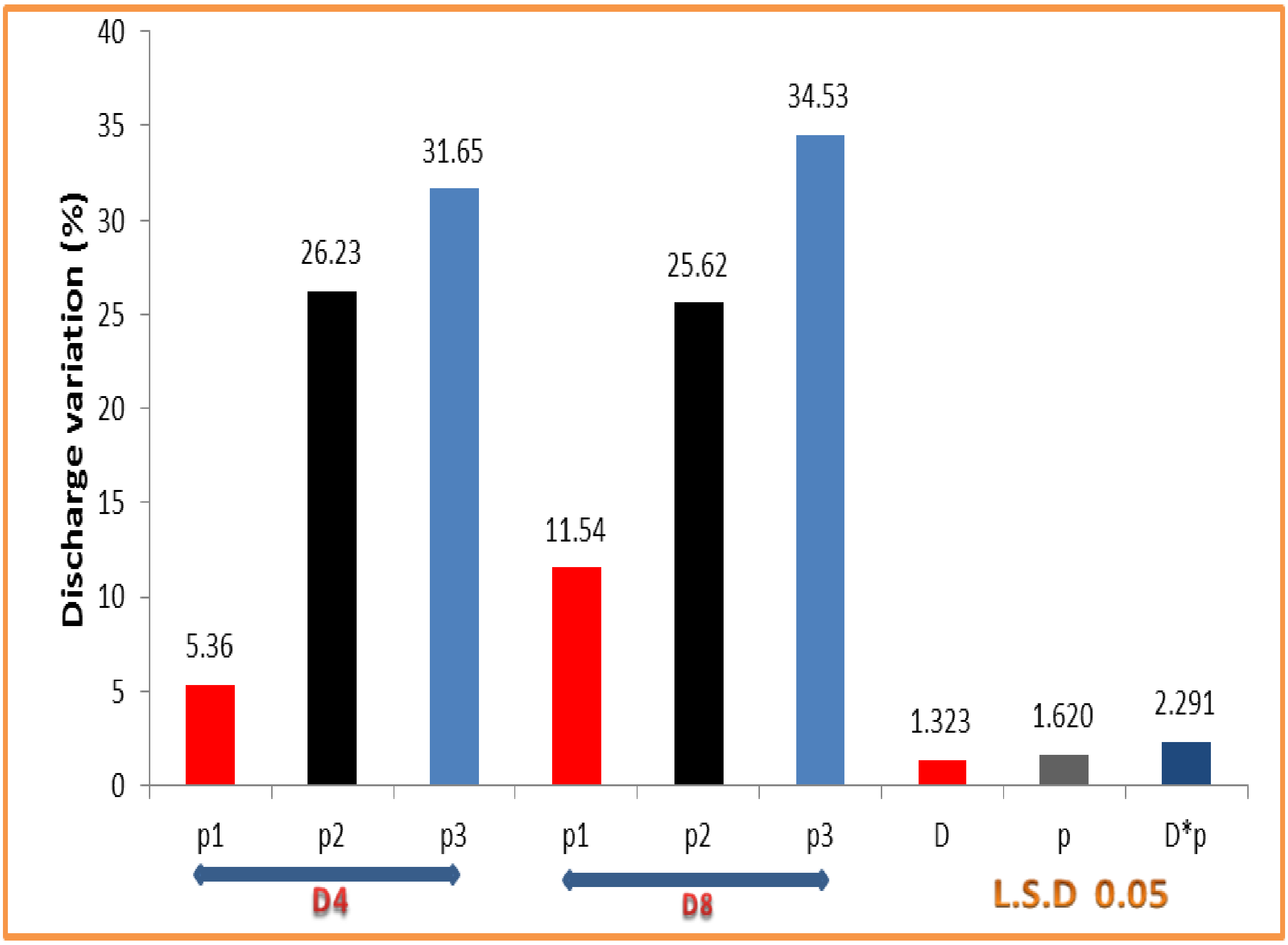

Fig.4.Effect of emitter's discharge and operational pressure in the values of discharge variation

Emission uniformity

Figure 5 illustrates that the values of emission uniformity are inversely proportional to the operational pressure when depending emitters type GR whose discharge 4 and 8 Lh^{-1}, where it reached 97.82%, 91.44%, and 90.85% by increasing the operational pressure from 0.5 bar to 0.7 bar and 1.0 bar when depending emitters whose discharge 4 Lh^{-1}, respectively, while it reached 94.45%, 91.76%, and 90.76% when depending emitters whose actual discharge 8 Lh^{-1} at the operational pressures 0.5 bar, 0.7 bar, and 1.0 bar, respectively. Then the values of lowest significant difference (L.S.D) showed a significant decrease in the values of emission uniformity by the effect of discharge and operational pressure and the interference between them. And this may be attributed that as the values of emission uniformity increase, water distribution in the field is regular, and that occurred when depending an operational pressure 0.5 bar for both discharge. This is consistent with what mentioned by Ortega *etal.*(13) who defined the emission uniformity as the ratio between discharge rate of the lowest quarter to the overall discharge rate of the emitters

Conclusion and recommendations

The emitters used are designed to endure low operational pressures (about 0.5 bar), where it gave highest values of uniformity coefficient and emission uniformity and lowest values of variation percentage in the emitter's discharge, so it is recommended to depend those emitters and for both discharge at the minimum operational pressure and the conditions of work similar to that study to distribute water in the field regularly, which may have a positive effect on the moisture distribution in the soil profile within the boarders of plant root.

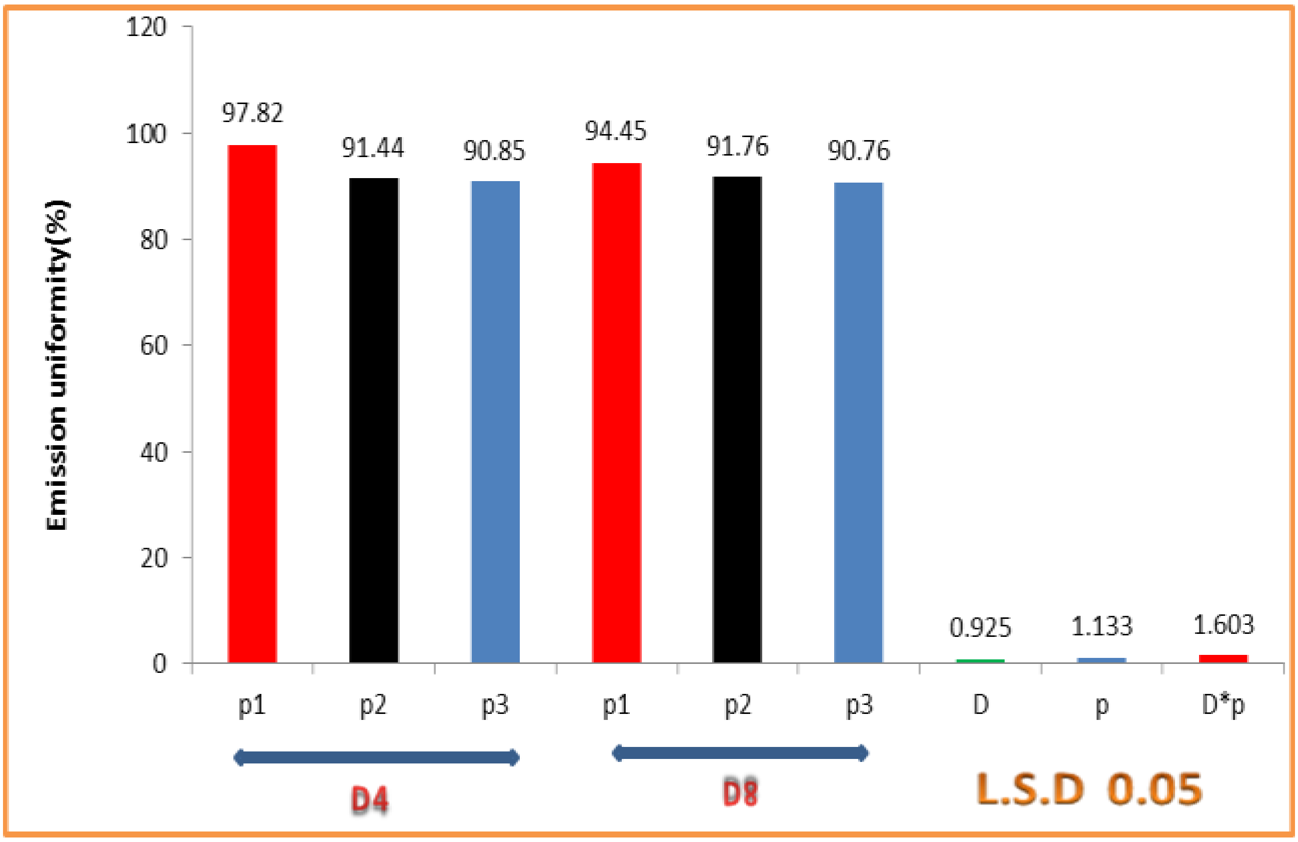

Fig.5.Effect of emitter's discharge and operational pressure in the values of emission uniformity

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