IMPACT OF FILTRATION AND CHLORINATION ON REDUCING CLOGGING IN DRIP EMITTERS

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ABSTRACT:

This study was aimed to reduce the clogging ratio using two waters qualities Sumael (LSI) and Bazalan (LSII). The physical treatment was carried out using complete filtration unit composed of three of filters (Hydrocyclone, Sand, and Disc filters) and application of hypo chloride (Ca $(OCl)_2$) 2 ppm as chemical treatment. Generally, physical treatment was more effective than chemical treatment to reduce clogging ratio for Sumael water (LSI). In contrast, for Bazalan water (LSII), the chlorine application was more practical to reduce clogging ratio. The results showed after the period of 320 hr, filtration reduces the clogging ratio for Sumael water (LSI) was 67.77% at clogging ratio 12.51%corresponding to 28.53% at clogging ratio 27.74%for chlorination when the clogging ratio for no treat was 38.82%. As opposed to Bazalan water (LSII), the improvement ratio for chlorination was 14.36% at clogging ratio was 7.56%. In case for filtration was improved to 10.42% when clogging ratio was 8.00% in comparing with no treat clogging ratio was 8.93%.

Keywords: clogging ratio, filtration units, chlorination, uniformity coefficient, water quality, wise consumption.

تقيم طريقتين الترشيح واضافة الكلورين في تقليل نسبة انسداد المنقطات باستعمال نوعين من ماء الري

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المستخلص

استعملت المعالجة الفيزياوية والكميائية لتقليل نسبة انسداد المنقطات على نوعين مختلفين من ماءالري ، وهما ماء سميل وبازلان. المعالجة الفيزياوية تمت باستعمال وحدة الترشيح الكاملة المتكونة من ثلاثة مرشحات (فلاتر) وهي (هايدروسايكلون، وفلتر الرملي و ديسك فلتر) و اضافة مادة الكلورين كمعالجة الكميائية وبتركيز2 جزء بالمليون. بشكل عام ، لوحظ أن المعالجة الفيزياوية كانت أكثر فاعلية من المعالجة الكيمائية للتقليل نسبة الانسداد بالمقارنة مع الكونترول (بدون معالجة) لماء سميل. في حين أن ماء بازلان، كانت المعالجة الكيمائية أكثر فعالية لتقليل نسبة الانسداد من وحدة الترشيح الكاملة ،وأظهرت النتائج أنه بعد مرور 320 ساعة من استعمال الفلاترتحسنت معدل تدفق ماء سميل بنسبة 67.77٪ عندنسبة انسداد 12.51%مقابل 28.53٪ للكلورين بنسبة الانسداد27.74% في حين نسبة الانسداد بدون المعالجة كانت38.82%. وعلى العكس من ماء بازلان ،حيث كانت نسبة تحسن باضافة الكلورين 14.36٪وبنسبة الانسداد كانت7.65%وفي حالة المعالجة الفيزياوية كانت نسبة التحسين 10.42٪وبنسبة الانسداد8.00% بالمقارنة مع بدون المعالجة ذات نسبة الانسداد 8.93%.

كلمات المفتاحية: نسبة الانسداد، وحدة الترشيح الكاملة، الكلورين،معامل التناسق، نوعية المياه، الاستهلاك المسؤول.

Received:26/5/2022, Accepted:4/8/2022

INTRODUCTION

Drip irrigation is the water distribution method that provides nutrients and water in precise amounts and at controlled frequencies directly to roots of plants through a pressurized network (4). Water is known as the main determinant of agricultural production (1). Significant component of an agricultural sustainable strategy has improved water use efficiency through quality management of irrigation system efficiency to up to 80%. This might be implemented utilizing modern irrigation techniques (23, 28). Water is essential for agricultural output, which is the key to global food production (8). Nowadays, our country is facing a major problem of water shortage because of water crisis around the world. Furthermore, the country is facing a dramatic water crisis as a result of current policies implemented by riparian countries on the one front and the drought that has occurred over the last few decades on another side (1, 24). As a result, there must be a strategy in place for the government to take immediate steps to alleviate the problems of water scarcity and environmental contamination, both of which have become important difficulties in recent years. Among all available solutions, drip irrigation could be the most suitable method to mitigate the water problem. In general, the drip irrigation system has a clogging problem. Still, there were no proper solutions for emitters clogging, in case this method became widely used during the last years. Clogging of drippers become a common problem when using drip irrigation system (17,19, 27). This obstacle appeared when using a fertilizer with water into the system, Also, insufficient operating pressure could be another reason.(10). Therefore, the poor efficiency of drip irrigation is the clogging of the emitters. Poor water quality causes emitter clogging in drip irrigation systems. Surface or groundwater can be used as a source of water, Physical, chemical, and biological clogging of emitters that are the three types of clogging (13). Chlorination has been identified as the least costly approach of removing biological growth to reduce the clogging ratio (21,16). Numerous chlorination methods with varying ejection rates and intervals of chlorine have been advocated by various studies (11). (16) Several chlorine injection schemes have been proposed, including a continuous low-level injection to obtain 1-2 mg L^{-1} of free chlorine at the end of the laterals, interval injections at end of each irrigation cycle at concentrations of 20 mg L^{-1}, and per week injections at a high concentration of 50 mg L^{-1}. Chlorination per two weeks with a 6-hour contact time and a free chlorine level of 2 mg L^{-1} at the end of the laterals actually reduced emitter clogging caused by the presence of biological clogging agents in the reservoir water (7). Numerous studies have been achieved about the emitter clogging using water that contains specific solid particle quantities (14, 30). Many studies were focused on problems related to clogging caused by solid particles with the size around 0.1-0.25 m, which is closely 1/7-1/3 of the flow depth, using the clogging assessment with lousy water quality (13,19). This study attempts to reduce the clogging ratios by means of filtration and chlorination. The complete unit of filtration has been used as a solution for physical clogging and the application of chlorine as another solution for chemical problems resulting from clogging. Filtration consider the main factor that could help to prevent emitter clogging (25), not capable to avoid it completely (26).

MATERIALS AND METHODS

Experimental description and design layout

A field study involving a drip irrigation system was carried out on an area of 434 m^2 table 1. The experiment in randomized completely block design (RCBD) using three replications was carried out to study a variety of responses of two factors on parameters of emitter performance in drip irrigation using two water qualities, Sumael water LSI (Langelier Saturation Index, I), and the second one was Bazalan LSII (Langelier Saturation Index, II). The main chemical water properties were showed in table 2. The langelier saturation index was calculated, the positive LSI suggests that $CaCO_3$ precipitation is possible. A high LSI value indicates that the water is corrosive to steel. The experiment was subdivided into three plots; control, Filtration (using the complete Filtration unit), and Chlorination (Application of Chlorine). The application was applied as follows

Table 1. some selected physical and chemical properties of study soil

Chemical properties	Measurements			
EC (dSm^{-1})	0.39			
pH	7.35			
O M ($g\ kg^{-1}$)	15.77			
$CaCO_3$ ($g\ kg^{-1}$)	159.82			
Soluble cation) (cmole / kg)	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}
	2.80	1.63	1.19	0.06
Soluble Anions (cmole/ kg)	Cl^{-}	SO_4^{2-}	CO_3^{2-}	HCO_3^{-}
	0.43	0.03	1.70	Trace
physical properties	PSD%			Textural Class
	Sand	Silt	Clay	
Texture	41.70	504.38	453.92	Silty Clay
Bulk Density $Mg\ m^{-3}$	1.462			

Table 2. The Chemical Characteristics of Two Qualities of Water used in the Experiment

Months	pH	Ec ds m^{-1}	TDS	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	$CO3^{=}$	$HCO3^{-}$	CL^{-}	SO^{-2}_4	SAR
				meq/L			Sumael (LSI)		meq/L			
October	7.88	0.89	569.6	4.8	7.2	1.19	0.03	0.6	7.8	0.7	4.12	1.38
September	7.76	0.87	556.8	4.8	6.2	0.97	0.05	0.4	8.0	0.9	2.72	1.29
August	7.68	0.88	563.2	4.4	7.4	0.94	0.08	0.8	6.8	1.1	4.12	1.27
July	7.52	0.92	588.8	4	8	1.78	0.05	0.4	7.2	1.2	5.03	1.65
June	7.76	0.87	556.8	3	8.4	0.98	0.03	0.6	7.4	1.3	3.11	1.28
							Bazalan (LSII)					
Months	pH	Ec ds m^{-1}	TDS	Ca^{+2}	Mg^{+2}	Na^{+} meq/L	K^{+}	$CO3^{=}$	$HCO3^{-}$ meq/L	CL^{-}	SO^{-2}_4	SAR
October	7.99	2.61	1670	7.20	2.80	0.59	0.01	0.40	3.00	0.90	6.39	2.87
September	7.98	2.71	1734	6.20	16.80	0.52	0.11	1.20	3.80	0.80	17.83	2.86
August	8.08	3.15	2016	7.40	12.90	0.74	0.16	0.60	3.00	0.80	16.88	3.38
July	7.64	2.95	1888	8.00	10.20	1.20	0.16	0.40	2.80	0.90	15.45	3.35
June	8.07	2.69	1722	8.40	16.20	0.60	0.16	0.60	1.20	0.90	22.67	2.86

USDA = SAR+EC dsm^{-1} Sodiciy is low, salinity is high

a-Install the complete infiltration unit

A complete filtration system was installed, which includes (hydro cyclone filters and sand filter, disc filter) that equipped separately with two sub mains plot to be able to have control on two water qualities. System was left to operate for 320 h without flushing, as the physical management to reduce the clogging capacity for two water qualities.

b-Install the tank for chlorination injection

The injection tank is equipped with two sub mains plots separately to apply chlorine with two water qualities.

Calcium hypochlorite Ca $(OCl)_2$, has been selected as cheap material was applied as chlorine in continuous irrigation with concentration (2 mg / Liter) for every two weeks each application was 4 h period, to be the second management to reduce the potential clogging ratio application of chlorine was through an injection tank provided with a pump. System pressure was monitored by the installed gage on the mainline (PE 100, 10 bar,32 mm). The system was operated for four hours. The sequence of sub-main plots consists of 10 emitters with operating discharges of 2 L/h set at 1 m intervals throughout the tube's length of six meters. The plots were spaced three meters apart and four meters apart between sub-main plots. System has applied water through two independent tanks with a capacity of 3 m^3 to provide experiment with two water qualities as illustrated in Fig.1

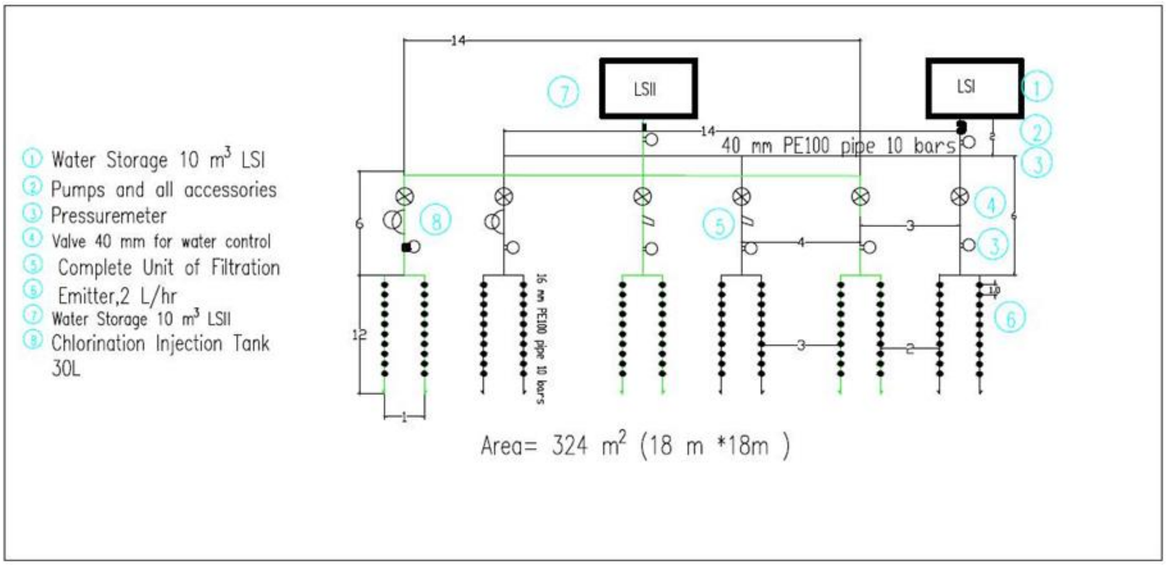

Fig.1. The layout of the experimental platform for the emitter clogging study using Filtration and chlorination treatment

Methods for estimating flow parameters for clogged emitters

Christiansen uniformity coefficient (CU)

The CU of drip irrigation emitters in each treatment was calculated using Eq. 1.

$$\mathbf{Cu = 100\left(1 - \frac{\Delta q_0}{q_0}\right)} \quad \mathbf{(1)}$$

Where Cu= denotes the Christiansen uniformity coefficient (%), Δq_o = is the average absolute deviation of the average of each emitter or lateral inlet flow, q_o=is the average emitter or lateral inlet flow. The acquired data were analyzed using the Cu ≥ % scenario, where the difference between the maximum and lowest emitter discharge is 10%. (20,21). The manufacturing variation coefficient (Cvm) has been computed using Equation 2. (7).

$$\mathbf{Cv = \frac{s}{\bar{x}}} \quad \mathbf{(2)}$$

X" indicates the average discharge of emitters in Equation 2, whereas "S" represents the standard deviation. A Cv value of less than 0.05 is considered very good, a value of 0.05-0.07 is considered good, a value of 0.07-0.11 is considered at the limit, a value of 0.11-0.15 Considered extremely poor, and a value of more than 0.15 is considered unsatisfactory in point source emitters (6). Equation 3 demonstrates the statistical uniformity of the emitters (6).

$$\mathbf{Us = 100(1 - V_q) = 100\left(1 - \frac{Sq}{\bar{q}}\right)} \quad \mathbf{(3)}$$

Us represents statistical uniformity (%), Vq represents the total change in emitter discharge, Sq represents the standard deviation of emitter discharge, and q represents the rate of emitter flow. Statistical uniformity is evaluated as great for 95-100 %, 85-90 %, tolerable for 75-80%, severely poor for 65-70 %, and unsatisfactory for 60% and lower (16). The term application uniformity (Eu) refers to the consistency of emitters under constant pressure (15). Eu is outstanding for 94-100 %, good for 81-87 %, acceptable for 68-75 %, severely bad for 56-62 %, and unacceptable for 50 % and less (3).

$$\mathbf{EU = 100\left(1 - \frac{1.27cv}{\sqrt{n}}\right)\frac{q_n}{q_a}(4)}$$

In this equation, Eu = denotes the of system application uniformity %, Cv = the manufacturing variation coefficient, n= is a number of emitters, qn = the lowest flow under the maximum downward pressure, and qa = the average emitter flow. The mean discharge ratio of emitters (Dra) provides a measurement of the deviation from the starting state caused by manufacturing. The Dra (%) was calculated by (20)

$$\mathbf{Dra = 100\frac{\sum_{i=1}^{n}\frac{q_i}{q_{ej}}}{n}} \quad \mathbf{(5)}$$

Where n = number of emitters tested n = 10 on each lateral for a certain time) ,q = field emitter discharge qe = discharge from a single emitter (L /hr)

Emitter sampling and measurement

Two water quality have been used in the drip irrigation system, the experiment lasted 16 weeks (from 11- June to 11- October), the operating time was 320 h in season, and the irrigation system was automated to irrigate four hours per day (9:00 a.m. to 2:00 p.m.) five days per week. The flow rate (q) and distribution uniformity (DU) of emitters were computed using a 100 mL measuring cylinder after 40 hours according to the (25). Catch cans were used to monitor the emitter's discharge, which was determined by counting individual flows from three selected emitters over 5 minutes and computing the flow rate (q) and distribution uniformity (DU). Three catch cans were installed along each lateral line, and the emitters at the (beginning, middle, and end) were chosen as plot samples. The operations were repeated four times over a period of four months. The quality of irrigation has a great role in reducing the emitter clogging; a complete filtration unit (Hydrocyclone, Sand filter, and disc filter) was connected with two water qualities Sumael (LSI) and Bazalan (LSII) respectively. In part, filtration is considered an effective solution to preserve and prevent the clogging potential and good system performance. A sand separator could be required in some situations when water contains a high amount of sand. The sand separators use centrifugal force to separate sand and other heavy particles from water. Sand separators that work properly can remove 70 to 95 % of heavy particles with comparable sizes larger than 0.003 inches. If necessary, sand separators should be built upstream of any filtration unit. Sometimes disc filters are used to remove organic particles from irrigation water. Disc filters are a cross between screen and media filters. Microscopic holes (usually made of plastic) between discs collect and trap undesired stuff (20). Hydrocyclone are enclosed cylindrical metal tanks that are inserted at the start of the head control unit as needed. They extract sand or silt from well or river water by creating centrifugal force within the filter via a vortex flow. This force forces the solids downward into a collecting chamber located below, allowing clean moisture to pass (3). Chlorination was chosen to clean the drip emitters in the drip irrigation system since it is the most popular approach for killing bacterial slimes. (13) Calcium hypochlorite $Ca(OCl)_2$, the application of chlorine was continuous with irrigation water 20 hrs during the week with a concentration of chlorine application was (2 ppm), the reasons behind for selecting the calcium hypochlorite due to its cheaply and wide market availability in the table (3) shows the main specifications of drip irrigation system.

Table 3. The Main Specifications of Drip Irrigation System

Item	Specifications
Electric pump	**0.5 horse power, 0.373 kw**
Disc Filters	**Material: Plastic** **Filtration Level: 120 mesh, 130 micron**
Hydrocyclone Filter	**High-quality standard thickness 3 mm** **Diameter of the machine: about 30 cm Machine height: About 119 to 121 cm Input pipe: 3 inches Output pipe: 3**
Sand Filter	**Inlet pipe size: 3Inch** **Device diameter: About 60 cm** **Height=130 cm**
Injection tank	**30 Liters vertical fertilizer tank with 1/2 inch inlet and outlet**
Main Line	**32 mm,PE100,10 bar**
Sub main	**25 mm,PE100,10 bar**
Lateral	**16 mm,PE100,10 bar**
Emitter (point Source)	**2 L/hr**

RESULTS AND DISCUSSION

Improving the Emitters Discharge Ratio

Results tables 4 and 5 show flow rate change compared with filtration and chlorination for Sumael water (LSI) and Bazalan water (LSII) over 320 h respectively. The complete filtration unit was equipped and chlorine application for both waters qualities. The quality of the irrigation water will influence the filtration, maintenance, and water treatment measures required to prevent emitter plugging and maintain system performance. The characteristics of the emitter, particularly the size of the emitter opening, also play a role (20). The flow rate improvement was appeared at the beginning compared to the control. The samples flow measurements were taken after 40 h of continuous irrigation. In general, the filtration was more effective to improve the flow rate of emitters for Sumael Water (LSI).

The improving rate is staring after the period of continuous water application where the ratio increased +6.177% in comparing to the control for Sumael water (LSI), while for the same water it becomes +5.913 % for chlorine application. The increasing rate for Bazalan water (LSII) was +3.714% for filtration when the ratio became double for chlorination application and became +6.764%. The improving rate for Sumael water (LSI) increased gradually over time while filtration was more effective than chlorination. In contrast, the flow rate becomes more improved with using of chlorine compared to filtration for Bazalan Water (LSII), in case the filtration treatment has effective too. As continuous irrigation and over the time flow rate of control decreased in comparing to filtration and chlorination. It was noticeable for both water Sumael (LSI) and Bazalan (LSII), the decreasing in flow rate for Sumael water (LSI) was remarkable after 240 h of continuous irrigation and flow rate was declined comparing to filtration and chlorination application. The filtration treatment improved the flow rate to increase +8.096%. In contrast to chlorine application it was +5.921%. At 320 h of continuous irrigation the improving of flow rate for filtration reach +69.730%. In comparing to the chlorine application, the improving rate reduced to half +30.394% utilizing the filtration improves remarkably the discharge stability. In contrast, the unfiltered water prompts to increase clogging. According to studies, utilizing water with suspended solids concentrations as high as 500 ppm did not result in emitter clogging as long as the larger particles were filtered (3). In Bazalan water (LSII), the chlorine application was more effective than filtration treatment. Over time, the flow rate improvement appeared compared to the control, but the improving difference was more significant with chlorine application. While after 240 h of continuous irrigation, the flow rate appeared to be more improved than filtration, where the flow rate for filtration was +4.630%, whereas for chlorination becomes +6.236. The most significant ratio was after 320 h when the flow rate improvement for chlorination became +11.152% correlated to filtration was +1.603. The key reason for chlorination application could be play a vital role to prevent the growth of alge and bacteria that create mucus to increase clogging potential. Furthermore, organic matter particles are deposited within emitters and cause clogging cementation with some bacteria such as enterobacteriaceae and pseudomonas, which cause clogging of emitter due to combination with organic particles and bacteria. This problem is available and may be the main reason for increased potential clogging. The mechanism of chlorination is used to control the clogging of emitters. The intermittent chlorine at a concentration of 1–20 mg/L could actually reduce emitter clogging caused by organic matter and algae sedimentation(11). The overall performance of the drip irrigation system was enhanced after the treatments of chlorination (13). Identical outcomes have also been observed by (19)

Table 4. Flow Rate Improvement with Filtration and Chlorination for Sumael Water over 320 hr

Periods	Emitters	Control	Filtration	%Improving	Control	Chlorination	%Improving
40 h	1	1.992	2.106	+5.723	1.992	2.184	+9.639
	2	1.932	2.064	+6.832	1.932	2.046	+5.901
	3	1.908	2.022	+5.975	1.908	1.950	+2.201
	%Average			+6.177			+5.913
120 h	1	2.040	2.304	+12.941	2.040	2.076	+1.765
	2	1.920	2.108	+9.797	1.920	2.016	+5.000
	3	1.878	1.962	+4.473	1.878	1.980	+5.431
	%Average			+9.070			+4.065
240 h	1	1.902	2.083	+9.527	1.902	2.116	+11.251
	2	1.872	1.872	0.000	1.872	1.972	+5.342
	3	1.626	1.866	+14.760	1.626	1.645	+1.169
	%Average			+8.096			+5.921
320 h	1	1.716	2.388	+39.161	1.716	1.847	+7.634
	2	1.554	2.004	+28.958	1.554	1.592	+2.445
	3	0.672	1.620	+141.071	0.672	1.217	+81.101
	%Average			+69.730			+30.394

Table 5. Flow Rate Improvement with Filtration and Chlorination for Bazalan Water over 320 h

Periods	Emitters	Control	Filtration	%Improving	Control	Chlorination	%Improving
40 h	1	1.974	2.052	+3.951	1.974	2.208	+11.854
	2	1.950	2.010	+3.077	1.950	2.022	+3.692
	3	1.896	1.974	+4.114	1.896	1.986	+4.747
	%Average			+3.714			+6.764
120 h	1	2.010	2.090	+3.980	2.010	2.064	+2.687
	2	1.926	2.004	+4.050	1.926	2.040	+5.919
	3	1.908	1.998	+4.717	1.908	2.022	+5.975
	%Average			+1.414			+5.193
240 h	1	2.010	2.090	+3.980	2.010	2.064	+2.687
	2	1.926	2.004	+4.050	1.926	2.040	+5.919
	3	1.908	1.998	+4.717	1.908	2.022	+5.975
	%Average			+4.630			+6.236
320 h	1	2.010	2.090	+3.980	2.010	2.064	+2.687
	2	1.926	2.004	+4.050	1.926	2.040	+5.919
	3	1.908	1.998	+4.717	1.908	2.022	+5.975
	%average			+1.603			+11.152

Dynamic improve of flow rate in clogging ratio : The results presented in table 6 and 7 shows the clogging ratio percentage concerning the control for two different waters qualities. Filtration and chlorination were used to reduce the clogging ratios. These two treatments were improved the flow rate for two water qualities in different ratios. The key for understanding the improving ratio was how does the using treatment capable to reduce the clogging potential over time. Filtration was more effective than chlorination for Sumael water (LSI), while in Bazalan water (LSII) the chlorination was more competent than filtration in comparison to the control. At the first period of continuous irrigation for Sumael water (LSI) the clogging ratio was 9.404% for control this ratio was reduced to 1.085% it means the filtration improved the emitters to 88.46%. Whereas for chlorination, the improvement was lower than filtration and it was 56.43%. Over time filtration improved the flow rate to reach 67.77% corresponding to 28.53% for chlorination. In general, for Bazalan water (LSII) chlorination considered to be more efficient than filtering treatment. At the first period the filtration improved the flow rate 100% comparable to chlorination 94.23%, then the efficiency of filtration to reduce the flow rate with time at 120 h for filtration 32.92% and became double to be 64.63%. The improvement ratio for flow rate after 320h became 14.36% for chlorination and 10.42% for filtration.

Table 6. Improving the flow rate depending on reducing clogging ratio with using two treatment filtration and chlorination for Sumael water (LSI)

Periods	Clogging Ratio %			Improving Percentage Respect to Control	
	Control	Filtration	Chlorination	Filtration	Chlorination
40 h	9.40	1.08	4.09	88.46	56.43
120 h	9.87	3.91	5.77	60.37	41.50
240 h	16.20	9.66	11.03	40.34	31.89
320 h	38.82	12.51	27.74	67.77	28.53

Table 7. Improving the flow rate depending on reducing clogging ratio with using two treatment filtration and chlorination for Bazalan water (LSII)

Periods	Clogging Ratio %			Improving Percentage Respect to Control	
	Control	Filtration	Chlorination	Filtration	Chlorination
40 h	7.41	0.00	0.42	100.00	94.23
120 h	7.79	5.22	2.75	32.92	64.63
240 h	8.46	6.55	6.17	22.47	26.96
320 h	8.93	8.00	7.65	10.42	14.36

Evaluation performance parameters of drip irrigation: In order to evaluate the emitter's performance test, the main parameters were calculated. This parameter used to evaluate the drip irrigation system were coefficient of variation (C.V), emission uniformity (EU) and statistical uniformity (US). The performance parameters indicators that were used to estimate the drip irrigation system are flow rate (q) statistical uniformity (Us), the emitter clogging ratio (CR), the mean discharge Ratio (Dra), and Christiansen's uniformity coefficient (CU) (9). Table (7) and (8) shows the system uniformity parameters using a complete filtration unit and application of chlorine for two waters Sumael (LSI) and Bazalan (LSII) respectively. Each treatment used two lateral lines with a total of 20 emitters. Six emitters were chosen from all of them to measure the flow rate. For all treatments, there were differences in the uniformity parameter. The flow rates for Sumael water (LSI) reduced with time, for control where no treated the variation was more noticeable, after the period of 40 h the emitter flow rate was 1.944 L/h and then reduced to 1.314 L/h after 320 hrs. For Bazalan water (LSII) flow rates changes slowly over time, after 40 h the flow rate recorded 1.948 L/h then after 320 h the reduced to 1.916 L/hr. Water quality has great role in reducing clogging potential the variation in emitters discharge was small for Bazalan water (LSII), whereas in Sumael water (LSI), the changing in emitters flow rate was considerable. Using complete filtration units and apply continuous chlorine make the flow rate more improve than no treat, but the effect of filtration treatment was more noticeable in Sumael water (LSI) than in Bazalan water (LSII). In contrast, the chlorination for Bazalan water improved the flow rate more than filtration. Furthermore, the other parameters were improved according to the emitter's flow rate. Overall, the C.V values for control for both water quality was more than 0.05, these criteria for coefficient variation (CV) were classified according to (3)of drippers was classified excellent when the value was less than 0.05 for point source drip. In general, the CV values for control were low, ranged between 0.022 and 0.061, for Sumael water. Whereas in Bazalan water (LSII), 0.045 to 0.069. The C.V value for Sumael water (LSI) for organic matter application ranged between 0.085 and 0.220 while for Bazalan (LSII), the value ranged between 0.122 and 0.316. Soil suspension for Sumael (LSI) has C.V value between 0.072 and 0.118; these values were found lower for Bazalan (LSII) and ranged between 0.059 and 0.062. These coefficient variation (CV) criteria were classified as excellent according to (3) of drippers when the value was less than 0.05 for point source drip. The values found in Sumael water (LSI) from 40 h to 320 h were as follows, no treat ranged from 0.07 to 0.341 and for filtration ranged between 0.0077 to 0.0944, and 0.0296 to 0.227 for chlorination. Bazalan water (LSII) the CV values recorded for no treat between 0.054 after 40 h and became 0.066 at 320 hrs. filtration and chlorination the CV values for 40 to 320 h were 0.000 to 0.059 and 0.021 to 0.077.(22)identified the clogging ratio based on flow rate for a single emitter as unclogged if the outflow is greater than 95 % of the initial flow, and 80-95 % as slightly clogged. Generally, a clogged emitter is defined as having a ratio of 50-80 %, with 20-50 percent considered seriously clogged and % or less considered entirely clogged. The treatment application has a great role for reducing the clogging potential for both water qualities. Sumael water (LSI) filtration was more effective than chlorination. In the same way, the filtration for Bazalan water was more active to reduce the clogging ratio than chlorination. Sumael water (LSI) the clogging ratio after 40 h was 1.085% corresponding to 9.40% for no treatment then over the time of the clogging potential reduction regarding to the no treat. The clogging potential for no treat reach to 38.827% after 320 h while for filtration was 12.514% it means the filtration reduced the clogging potential to one third when comparing to no treat. Chlorination for the Sumael water (LSI) the clogging ratio was 4.097% after 40 h then it became 27.747% after 320 h whereas, the reducing ratio was only one quarter compering to the no treat. The reason filtration was more effective than chlorination for Sumael water (LSI) it could return to the chemical composition of water and it is reactions with chlorine to increase the clogging potential. Bazalan water (LSII) filtration decreased the clogging potential to 100%. It means there was no clogging potential after 40 h corresponding to the 7.414% for no treat. The clogging potential appear to increase over time for no treat, but the rate of increase was less compering to the Sumael water (LSI). In general, the degree of reduction in discharge flow rates was expressed by the Dra. The emitter is considered clogged if the Dra value is less than 75% (29). Overall, the Dra% for Sumael water (LSI) was acceptable except after 320 h for no treat and chlorination the Dra% value was less than 75% and it was 61.173% and 72.253% respectively. In case, the Dra% for Sumael water (LSI) for filtration was 87.48%. The Dra% for Bazalan water (LSII) considered unclogged emitter for all treatments.(10) The Formula was used to calculate the uniformity of emitter coefficients. According to (2), the uniformity coefficient (Cu) is classified as follows: It can be interpreted as excellent if it is value 90 % or higher, very good if it is 80-90 %, fair if it is 70-80 %, poor if it is less than 60-70%, and unacceptable if it is less than 60%. The Cu% values for both waters Sumael (LSI) and Bazalan (LSII) after 40 h was considered to be excellent, for Sumael water (LSI) Cu% values reduced with time, for no treat was declined and became 75.91% after 320 h. In contrast, for filtration the values remain in excellent range and it was 93.325%, whereas, for chlorination the values reduced to be in the range of very good when the value was 83.89%. Bazalan water (LSII) the Cu% values remained in the range of excellent for all treatments. The criteria for determining statistical uniformity of emitters (14) classified Us as being between 95 and 100 %. It is categorized as perfect, 80 to 90 % good, 75 to 80 % tolerable, 65 to 70 % very bad, and less than 60 % unacceptable. In general, the statistical uniformity Us% For Sumael water (LSI) after 40 hours it was in the good range and the values ranged between 92.95% after 40 h. While, the value reduced to 65.931% after 320 h to be in the range of very bad. For the same water the values of Us% for filtration treatment from the period of 40 to 160 was 99.22 to 95.09 respectively, and remaining in the perfect range. For the rest period was reaming in the range of good. In contrast, for chlorination the Us % for Sumael water (LSI) from 40 to 120 hrs was in the perfect range, the values were between 97.04 to 95.79%. After 320 h, the rate decreased to 77.22% and thus became within the good range. It's clear that the filtration treatment has a great impact to reduce the clogging ratio comparing to the no treat for two water qualities. Many studies referred that filtration could be the most available solution to reduce clogging potential.(18) the removal efficiencies achieved by the various filters with the two effluents used in the experiments. The only parameters whose removal efficiencies were affected by the filtration system were turbidity and total suspended solids (TSS) in both effluents, and dissolved oxygen in effluent 2. The sand filter reduced turbidity by 57.6 % in effluent 1 and 66.4 % in effluent 2. It also removed 47.3 percent and 66.6 percent of the total suspended solids (TSS) from effluents 1 and 2, respectively. The clogging of emitters is directly related to effluent quality. Filtration is a necessary operation that can help prevent emitter clogging(21).

Table 7. System uniformity parameters for Sumael water quality (LSI)

Water Quality		Performance parameter values					
Sumael (LSI)	**Periods**	**q L/hr**	**CV**	**CR%**	**Dra%**	**Cu%**	**Us%**
No treat	**40 h**	**1.94**	**0.07**	**9.40**	**90.59**	**95.01**	**92.95**
	120 h	**1.94**	**0.07**	**9.87**	**90.13**	**95.06**	**93.02**
	240 h	**1.80**	**0.12**	**16.20**	**83.79**	**91.18**	**87.53**
	320 h	**1.31**	**0.34**	**38.82**	**61.17**	**75.91**	**65.93**
Filtration	**40 hr**	**2.12**	**0.00**	**1.08**	**98.91**	**99.45**	**99.22**
	120 h	**2.06**	**0.02**	**3.91**	**96.08**	**98.00**	**97.18**
	240 h	**1.94**	**0.07**	**9.66**	**90.33**	**94.92**	**92.81**
	320 h	**1.87**	**0.09**	**12.51**	**87.48**	**93.32**	**90.56**
Chlorination	**40 h**	**2.06**	**0.02**	**4.09**	**95.90**	**97.90**	**97.04**
	120 h	**2.02**	**0.04**	**5.77**	**94.22**	**97.02**	**95.79**
	240 h	**1.91**	**0.08**	**11.034**	**88.96**	**94.16**	**91.74**
	320 h	**1.55**	**0.22**	**27.74**	**72.25**	**83.89**	**77.22**

Table 8. System uniformity parameters for Bazalan water quality (LSII)

Water Quality Bazalan (LSII)	Periods	q L/hr	CV	CR%	Dra%	Cu%	Us%
		Performance parameter values					
No treat	**40 h**	**1.94**	**0.05**	**7.41**	**92.58**	**96.15**	**94.55**
	120 h	**1.94**	**0.05**	**7.79**	**92.20**	**95.94**	**94.26**
	240 h	**1.92**	**0.06**	**8.46**	**91.54**	**95.58**	**93.75**
	320 h	**1.91**	**0.06**	**8.93**	**91.06**	**95.32**	**93.38**
Filtration	**40 h**	**2.10**	**0.00**	**0.00**	**100**	**100**	**100**
	120 h	**1.99**	**0.03**	**5.22**	**94.77**	**97.31**	**96.20**
	240 h	**1.96**	**0.04**	**6.55**	**90.68**	**96.60**	**95.20**
	320 h	**1.93**	**0.05**	**8.00**	**91.99**	**95.83**	**94.10**
Chlorination	**40 h**	**2.10**	**0.02**	**2.95**	**97.04**	**98.50**	**97.88**
	120 h	**2.04**	**0.04**	**5.62**	**94.37**	**97.10**	**95.90**
	240 h	**1.97**	**0.06**	**8.94**	**91.05**	**95.31**	**93.37**
	320 h	**1.94**	**0.07**	**10.37**	**89.62**	**94.52**	**92.26**

CONCLUSIONS

Its concluded that the complete filtration unit was effective to reduce the clogging ratio comparing to chlorine application for Sumael water (LSI). While, chlorination was more effective than filtration for Bazalan water (LSII). Emitter discharge efficiency (CR), manufacturing variation coefficient (CV), emission uniformity (Eu), and statistical uniformity (Us) are with enough performance parameters for emitters under both chlorination and filtration. Finally, Filtration may be appropriate for one type of water and chlorination for another.

REFERENCES

1. Al-Timimi, Y.K., and F. Y. Baktash. 2024. Monitoring the shift of rainfed line of 250 mm over Iraq. Iraqi Journal of Agricultural Sciences, 55(3): 931-940. https://doi.org/10.36103/h10cqh53.

2. ASAE, S. 2000. Field evaluation of microirrigation systems (EP458): 918-924

3. ASAE, S. 2003. Method of determining and expressing fineness of feed materials by sieving. ASAE Standards: 588–592.

4. Asgari, A., F. Ejlali, F. Ghassemi-Sahebi, I. Pourkhiz, Q. Branch and I. Qaemshahr. 2012. Assessment of emitter clogging by chemical componen t on water application uniformity in drip irrigation. International Research J. of Applied and Basic Sciences, 3(9): 1813-1817.

5. Bounoua, S., S.Tomas, J. Labille, B. Molle, J. Granier,P. Haldenwang and S.N. Izzati.2016. Understanding physical clogging in drip irrigation: in situ, in-lab and numerical approaches. J. of Irrigation Science, 34(4) :327-342.

6. Bralts, V.F. and C.D. Kesner 1983. Drip irrigation field uniformity estimation. Transactions of the ASAE, 26(5) :1369-1374.

7. Capra, A. and B. Scicolone .2007. Recycling of poor quality urban wastewater by drip irrigation systems. J. of Cleaner Production, 15(16) :1529-1534.

8. Capra, A. and B. Scicolone.1998. Water quality and distribution uniformity in drip/trickle irrigation systems. J of Agricultural Engineering Research, 70(4) :355-365.

9. Chauhdary, J.N., A. Bakhsh, N. Ahmad and K. Mehmood. 2015. Optimizing chlorine use for improving performance of drip irrigation system under biologically contaminated water source. Pak. J. Agric. Sci, 52(3):829-835.

10. Christiansen, J.E.1942. Irrigation by sprinkling (Vol. 4). Berkeley: University of California.

11. Dehghanisanij H, T. Yamamoto, B.O. Ahmad, H. Fujiyama, K and Miyamoto. 2005. The effects of chlorine on emitter clogging induced by algae and protozoa and the performance of drip irrigation. Transactions of the ASAE, 48: 519-527.

12. Duran-Ros, M., J. Puig-Bargués, G. Arbat, J. Barragán and F.R. De Cartagena. 2009. Effect of filter, emitter and location on clogging when using effluents. J. of Agricultural Water Management, 96(1):67-79.

13. English, S.D. 1985. Filtration and water treatment for micro-irrigation. in In Proc. 3rd Int. Drip/Trickle Irrig. Congress:50−68. St. Joseph, Mich. ASAE.

14. Haman, D.Z.1989. Settling basins for trickle irrigation in Florida. University of Florida Cooperative Extension Service, Institute of Food and Agriculture Sciences, EDIS.

15. Keller, J. and D. Karmeli.1974. Trickle irrigation design parameters. Transactions of the ASAE, 17(4) :678-0684.

16. Li, J.S., Y.F. Li and H. Zhang .2012. Tomato yield and quality and emitter clogging as affected by chlorination schemes of drip irrigation systems applying sewage effluent. J. of Integrative Agriculture, 11(10) :1744-1754.
17. Niu, W., L. Liu and X. Chen. 2013. Influence of fine particle size and concentration on the clogging of labyrinth emitters. J. of Irrigation Science, 31(4) :545-555.
18. Oron, G., G. Shelef and B. Turzynski. 1979. Trickle irrigation using treated wastewaters. J. of the Irrigation and Drainage Division, 105(2):175-186.
19. Pei, Y., Li. Liu, Y. Zhou, Y. B. Z. Shi and Y. Jiang. 2014. Eight emitters clogging characteristics and its suitability under on-site reclaimed water drip irrigation. J. of Irrigation Science, 32(2):141-157.
20. Phocaides, A. 2000. Technical Handbook On Pressurized Irrigation Techniques. FAO, Rome, 372.
21. Pitts, D.J., D.Z. Haman and A.G. Smajstrla. 2003. Causes and prevention of emitter plugging in microirrigation systems. Institute of Food and Agricultural Sciences. Bulletin, 258.
22. Qingsong, W., Gang, L., Jie, L., Yusheng, S., Wenchu, D. and Shuhuai, H., 2008. Evaluations of emitter clogging in drip irrigation by two-phase flow simulations and laboratory experiments. Computers and Electronics in Agriculture, 63(2), pp.294-303.
23. Rasheed, Z. K. 2022. Modeling of subsurface horizontal porous pipe irrigation under different conditions. Iraqi Journal of Agricultural Sciences, 52(4):949-959. https://doi.org/10.36103/ijas.v52i4.1405
24. Sharef, A. J., R. N. Dara and A. R. Ahmed. 2021. Alana river basin management. Iraqi Journal of Agricultural Sciences, 52(6): 1304-1317. https://doi.org/10.36103/ijas.v52i6.1470
25. Tajrishy, M.A., D.J. Hills and G. Tchobanoglous. 1994. Pretreatment of secondary effluent for drip irrigation. J.of Irrigation and Drainage Engineering, 120(4) :716-731.
26. UCcedil, K. 2013. Elimination of lime causing clogging in emitters by chemical methods in drip irrigation. African J. of Agricultural Research, 8(13): 1136-1143.
27. Yavuz, M.Y., K. Demrel, O. Erken, E. Bahar and M. Devecler . 2010. Emitter clogging and effects on drip irrigation systems performances. African J. of Agricultural Research, 5(7): 532-538.
28. Zhang, T., Y. Zou, I. Kisekka, A. Biswas, and H. Cai. 2021. Comparison of different irrigation methods to synergistically improve maize's yield, water productivity and economic benefits in an arid irrigation area. J. of Agricultural Water Management, 243 :106497.
29. Zhangzhong, L., P. Yang, W. Zheng, C. Wang, C. Zhang and M. Niu. 2018. Effects of drip irrigation models on chemical clogging under saline water use in Hetao District, China. Water, 10(3):345.
30. Zhengying, W., T. Yiping, W. Juying and L. Bingheng. 2008. Two-phase flow analysis and experimental investigation of micro-PIV and anti-clogging for micro-channels of emitter. Transactions of the Chinese Society of Agricultural Engineering (Transactions of the CSAE), 24(6) :1-9.