https://doi.org/10.26682/ajuod.2022.25.1.13
Journal of University of Duhok.,Vol. 25, No.1 (Agri. and Vet. Sciences), Pp 122-140, 2022

EFFECT OF ORGANIC MATTER AND SOIL SUSPENSION ON CLOGGING DRIP EMITTERS UNDER APPLICATION TWO DIFFERENT WATER QUALITIES

ZERAVAN **A**. **A**BDULLAH and **A**KRAM **A. K**HALAF
Dept. Soil and Water, College of Agricultural Engineering Science, University of Duhok, Kurdistan Region-Iraq

(Received: March 28, 2022; Accepted for Publication: May 19, 2022)

ABSTRACT

One of the most critical variables affecting the performance of drip irrigation systems is emitter clogging, which occurs quickly as a result of irrigation systems operating under insufficient pressure or due to poor water quality, not only affecting water distribution uniformity but also results in insufficient irrigation. To investigate the clogging potential of the drippers, two types of water quality were tested. Using local materials organic matter and soil suspension account for more than 47 percent of the clay content was applied with water. The tests identified the clogging severity of emitters with organic matter application for both water qualities Sumael (LSI) and Bazalan (LSII) respectively. In general, clogging ratios developed with time for both water qualities, the most distinct was organic matter application that reduced the discharge rate to 15.561% for Sumael water (LSI) corresponding to Bazalan water (LSII) was 38.002%. The flow rate of the drippers was also affected by the soil suspension particles. The percentages found in the Bazalan water was 5.62%, which was close to 5.575% in the Sumael water.
Key Words: Clogging ratio, Water quality, Emitter performance, uniformity coefficient

INTRODUCTION

In arid and semi-arid areas, the quantity and quality of water resources are the limiting factors of agricultural development. It seems that using and developing drip irrigation technologies is one of the ways to achieve scientific agriculture. Our region now is facing a major issue of water scarcity and could worse in the future with rising population pressures. The government should have a vision on water management and take proper steps to ensure the water future. However, drip irrigation systems are methods of water distribution which deliver water and nutrients to precise amounts and control frequencies directly to the plants' root via the pressurized network. Due to low water resources and the environmental impacts of traditional water systems, drip irrigation technology is becoming increasingly attentive and essential in agricultural production. Particularly with high-value cash crops such as greenhouse crops, ornamentals and fruit (Pescod 1992).

Keller and Blaisner (1990) noted that one of the most successful irrigation systems is drip irrigation. Pei, *et al.,* (2014) found that the most efficient and safe method of revived irrigation is drip irrigation. The most common type of clogging is caused by particles in suspension and physical processes.

These particles are generally part of the soil and are classified according to their mean diameter as follows: sand (2 to 0.05 mm), silt (0.05 to 0.002 mm), and clay (less than 0.002 mm) (Bucks DA, Nakayama FS, 1979 and Pitts, et.al. 2003). As a result, numerous studies on emitter clogging using irrigation water with various solid particle concentrations have been conducted (Capra and Scicolone, 2007 and Wei *et al.*, 2008). Clogging can occur due to various factors (physical, chemical, or biological (Bucks DA, Nakayama FS 1979). Typically, clay particles are too small to clog drippers. Small diameter particles can pass through the filtering system and reach the drippers (Niu, Liu, and Chen 2013). Depending on the characteristics of the flow in the labyrinth, particles can be deposited in the vortices and stagnation zones inside the drippers, raising the risk of clogging (Bounoua et al. 2016). Even if the irrigation water has been filtered using a

zeravan.ariff@uod.ac

combination of sedimentation, grit filtration, and mesh screen, residual solid particles with a diameter smaller than 0.075 mm can still enter the emitter channel (Qian 2002). Using the clogging test with muddy water, the bulk of the study has focused on clogging problems caused by solid particles with sizes of roughly 0.1–0.25 mm, which is

approximately 1/7–1/3 of the channel width (Niu, Liu, and Chen 2013)., the numerical investigations have revealed that the key parameters influencing clogging are suspended particle velocity, particle sizes, and sediment concentrations when particle sizes exceed 0.05 mm, the probability of emitter obstruction increases considerably (Wei et al. 2008 and Liu et al. 2010). Suspended inorganic particles (sand, clay particles, etc.) and organic materials (plant and animal wastes, etc.) in water produce physical clogging (Nakayama and Bucks 1991). Organic gardeners that use low-volume irrigation systems have indicated a need for an organic fertilizer that may be safely pumped through their irrigation systems. When used for this purpose, readily available organic fertilizers such as fish emulsion typically clogged emitters. Some organic producers utilize Chilean nitrate (sodium nitrate), readily available and inexpensive nitrogen (N) source, but it has one drawback: it adds sodium to the soil. Sodium nitrate formulations often include up to 26 per cent sodium. High sodium levels in the soil can cause scattered soil with limited infiltration. (McGourty 1992). The following are the study's objectives:

1- To characterize the materials which affect dripper performance. Such as soil suspension and organic fertilizers.

2- To investigate the susceptibility of emitter clogging potential utilizing two water qualities.

MATERIALS AND METHODS

Experimental location and materials

The field experiment located on the experimental area specialized for research in the College of Agricultural Engineering Sciences, the University of Duhok in the Iraqi Kurdistan Region. The college is located at Sumael, about 13 km west of Duhok city (36^o $51^{'}$ N, 52^o $02^{'}$ E) and an altitude of 473 m a.ms.l. Topographic survey of the field has shown to be flat with has relatively constant south facing, where the slope is near to 1%. It is estimated that the skill area for the experiment is 2000 m^2. The main chemical properties of two water qualities, Sumael (LSI) and Bazaln (LSII), were examined these included are Electrical conductivity (EC) $dS.m^{-1}$, water hardness (Ca^{+2}, Mg^{+2}) was tested by EDTA method, the Na^+ and K^+ ions were estimated by flame photometer and CO_3^{-2} and HCO_3^- ions content was measured by acidimetric titration. Silver nitrate titration was used to assess the Cl^- ion concentration. The glass electrode method and a conductivity meter were used to determine the pH and EC of two water qualities, respectively. As illustrated in the table (1).

zeravan.ariff@uod.ac

Table (1): 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}
				Sumael (LSI)							
				Ppm				ppm			
October	7.88	0.892	570.88	96	86.4	27.4	1.3	18	475.8	24.85	131.988
September	7.76	0.877	561.28	96	74.4	22.4	2	12	488	31.95	87.206
August	7.68	0.882	564.48	88	88.8	21.8	3.1	24	414.8	39.05	132.074
July	7.52	0.924	591.36	80	96	41	2	12	439.2	42.6	161.085
June	7.76	0.878	561.92	60	100.8	22.7	1	18	451.4	46.15	99.603
				Bazalan (LSII)							
Months	pH	Ec $ds.m^{-1}$	TDS	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	$CO3^{=}$	$HCO3^{-}$	CL^{-}	SO^{-2}_{4}
				Ppm				ppm			
October	7.99	2.61	1670.4	144	33.6	13.6	3.8	12	183	31.95	204.440
September	7.98	2.71	1734.4	124	201.6	12	4.3	36	231.8	28.4	570.624
August	8.08	3.15	2016	148	155.76	17	6.4	18	183	28.4	540.263
July	7.64	2.95	1888	160	122.4	27.5	6.1	12	170.8	31.95	494.466
June	8.07	2.69	1721.6	168	194.4	14	6.3	18	73.2	31.95	725.447

Determination of Langelier saturation index value

The Langelier saturation index (LSI) was measured over five consecutive months throughout the testing period starting from (June, July, August, September, and October). The Langelier saturation index (LSI) was calculated to achieve the appropriate clogging levels in emitters. A positive LSI indicates the possibility of $CaCO_3$ precipitation. A low LSI value shows that the water is corrosive to steel (UCcedil, K. 2013). Figure 1 presents the LSI category and the criteria utilized in the computation. According to data analysis, LSI values were calculated using the following equation and fundamental factors:

$$LSI = pH + AF + CF + TF - 12.1$$

Where pH denotes the acidic-alkaline value of irrigation water (as determined by a pH meter); AF, alkalinity factor (measured in terms of Na ion concentration); CF is the calcium hardness factor (as determined by ion concentration); TF is the temperature factor (according to measured irrigation water temperatures) If, based on the computed LSI values, LSI > +2.0, highly scaled; +0.5 LSI +2.0, scaled; LSI = 0, water is neutral. Water is mildly corrosive at LSI -2. 0; water is very corrosive at LSI

zeravan.ariff@uod.ac

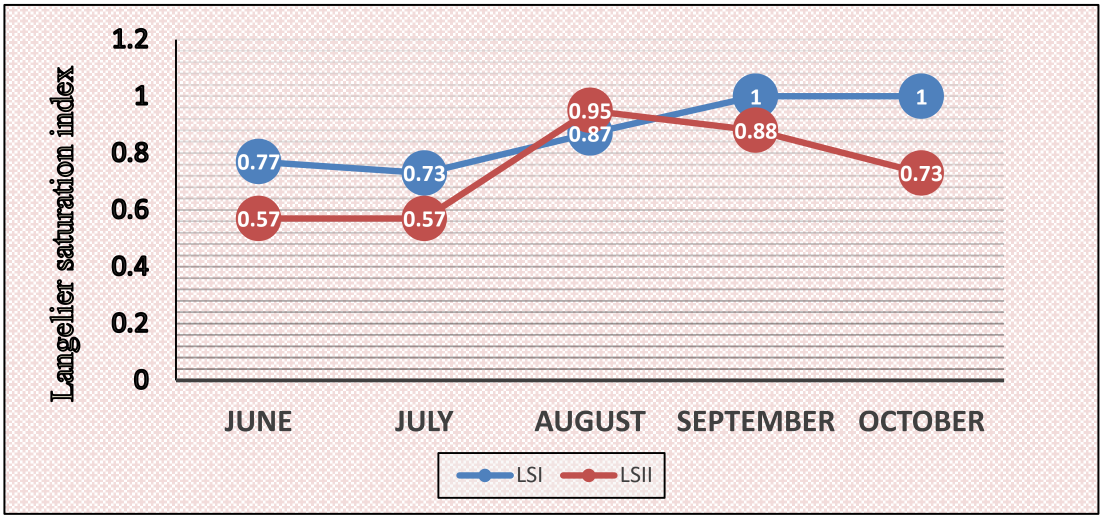

Fig.(1): Langelier saturation index as affected by variation in temperature over five months

Experimental description and design layout

A field study involving a drip irrigation system was conducted on area 434 m^2; the experiment in randomized completely block design (RCBD) was performed to study a host of responses of two factors on parameters of emitter performance in drip irrigation with two water qualities that had two levels, where the level one was in Sumael LSI (Langelier Saturation Index, I). Level two was in Bazalan LSII (Langelier Saturation Index, II). The experiment was subdivided into three main plots: the first is controlled, the second is equipped with an injection tank to supply the system with the application of organic matter, and the last main plot is also connected with the injection tank to provide the system with application of soil suspension. They were equipped to control the station with a pump. The system pressure was monitored by the installed gage on the mainline (PE 100, 10 bar,16 mm). The device control was established for four hours then shut off the system operation. The sequence of sub-main plots consists of 10 emitters with operating discharge 2 L/hr placed at 1 m on the six meters' length of the tube. The plots were set up in three meters' intervals and four meters between sub-main plots.

The system is equipped with two separate tanks with 3 m^3 to supply the experiment with two different water qualities. The experiment was set up without a filtration system. As shown in Fig.2

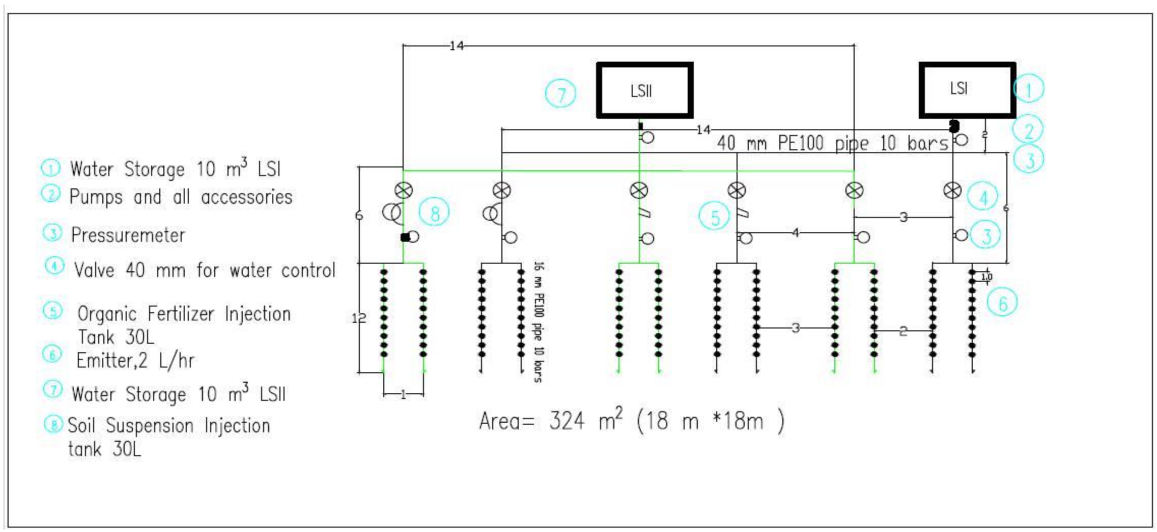

Fig. (2): The layout of the experimental platform for the emitter clogging study using organic matter and soil suspension application.

zeravan.ariff@uod.ac

Methods of calculating discharge parameters for emitters clogging

Christiansen uniformity coefficient (CU)

Eq. 1 was used to compute the CU of drip irrigation emitters in each treatment.

$$\text{Cu} = 100\left(1 - \frac{\Delta q_o}{q_o}\right) \quad [1]$$

Where

Cu = Christiansen's 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 obtained data were evaluated using the scenario of Cu ≥ %97.5 when the difference between the highest and lowest emitter discharge is 10% (KorukCu, 1980; YILDIRIM, O., & APAYDIN, H 1999). Equation 2 is manufacturing variation coefficient (Cvm) has been calculated according to (ASAE 2002)

$$c_v = \frac{s}{\bar{x}} \quad [2]$$

In Equation 2, "X" represents the average flow of emitters, while "S" represents the standard deviation. In point source emitters, a Cvm value of less than 0.05 is deemed to be 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 is considered extremely bad, and a value of more than 0.15 is deemed to be unsatisfactory (ASAE 2002).

The statistical uniformity of the emitters has been proven by Equation 3 (Bralts and Kesner; 1983)

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

Us is denoted by statistical uniformity (%), Vq is the overall change in emitter flows, Sq is the standard deviation of emitter flows, and q denotes the rate of emitter flow. Statistical uniformity is rated as perfect for 95-100 %, 85-90 %, tolerable for 75-80 per cent, extremely poor for 65-70 per cent, and unsatisfactory for 60 % and below (ASAE 1994).

The term application uniformity (Eu) refers to the uniformity of emitters under continuous pressure (ASAE 1994). According to ASAE (1994) criteria, Eu is classified as excellent for 94-100 %, good for 81-87 %, acceptable for 68-75 %, extremely bad for 56-62%, and unsatisfactory for 50 percent and less than it, as specified by (Keller and Karmeli, 1974)

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

In the equation, Eu = represents system application uniformity%, Cvm = represents manufacturing variation coefficient, n= represents the number of emitters, qn = represents the lowest flow under the most downward pressure, and qa = represents the average emitter flow.

Emitter Sampling and Measurement

Two water qualities were applied in the drip irrigation system, the period of the experiment was four months (starting from June to October), the operation time was taken to be 320 hours in season, the irrigation system was automated to irrigate four hours in a day started (9:00 am to 2:00 pm) over five days in a week. The flow of emitters was measured after 40 hrs according to the Wilcox et.al. (1970) catch cans were used to monitor the emitter's discharge, which was determined by counting individual flows from three selected emitters over 5 min and computing the flow rate (q) and distribution uniformity (DU) using a 100-mL graduated cylinder. Three catch cans were placed along the individual lateral line, and the emitters at the (beginning, middle, and end) were chosen to be the samples from the plots. The procedures were repeated over the four months. The organic matter applied was local use, and it was chosen owing to its low cost and wide market availability. It was injected with water in the drip irrigation system table 2. Shows the analysis of organic matter applied. Before the injection, the ratio of 25 g/L was taken in the mixture and mixed with 200 ml of water; the mixing time was 5 min, then the sample was completed in 1000 ml of water and keeps it in a plastic bottle to be ready for injection Fig.3. During all 320 hrs of operating the system, each bottle was applied to the system through an injection tank with 30 liters. 80 bottles of mixture samples were used in the experiment. The applied soil was chosen because it had high clay content, and the texture name was classified as silty clay. The soil suspension was added at a ratio of 15 g per liter through an equipped tank with 30 L. The suspension was prepared in the laboratory before application table 3 displayed some selected soil physical and chemical properties. The weighted mud was mixed for 5 min then completed to 1 L and then placed in the plastic bottle figure 4 shows the plastic bottle of soil suspension in the laboratory.

zeravan.ariff@uod.ac

Table (2): Some selected chemical properties of applied organic matter

N%	O.M%	O.C%	C:N	pH	EC ds.m^{-1}	Ca^{+2} %	Mg^{+2} %
0.784	92.49	50.45	64.4	5.5-6.5	0.5-1.5	0.05	0.80

N is nitrogen percentage, O.M is organic matter, C: N is carbon to nitrogen ratio, EC is Electrical conductivity.

Fig. (3): plastic bottle of applied organic 25g/L

Fig. (4): plastic bottle of applied soil suspension 15g/L

Table (3): Some selected physical properties of applied soil suspension**.**

Chemical properties	Measurements			
EC (dSm^{-1})	4.21			
Ph	7.3			
Soluble cation (ppm)	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}
	646	147.72	18	16
Soluble Anions (ppm)	Cl^{-}	SO_4^{2-}	CO_3^{2-}	HCO_3^{-}
	1274.5	84.44	0	140.18
Physical properties		PSD%		Textural Class
	Sand	Silt	Clay	
Texture	6.4	46	47.6	Silty Clay
Bulk Density Mg m^{-3}	1.21			

RESULT AND DISCUSSION

Impact of application local materials on clogging ratio

Table (4) and Table (5) show the measurements of clogging ratio for the initial and final stage of flow rate over a period of 320 hrs for Samael water (LSI) and Bazalan (LSII), respectively. The flow measurement was started after every 40 hrs of continued irrigation over 320 hrs. The reduction of measured discharge was singed to clogging for all treatments in different percentages. A gradual reduction in flow rate for control LSI comes after several runs of irrigation. The remarkable reduction in average flow rate appeared after irrigation application of 160 hrs it was observed (-10.229%) and become more severe over 320 hrs to reached (-12.627%). In contrast for LSII, the average percentage for control after 40 hrs was (-5.979%), then the rate remained around 8% until the end of the experiment to (-9.336%). The maximum reduction of organic matter application for LSI occurred after 280 hrs was (-25.145%) compared to LSII (-37.783%). The flow rate in soil suspension was reduced regularly. It was noticed (-12.37%) for LSI over a time 240 hrs,

zeravan.ariff@uod.ac

similarly to LSII the at time 200 hrs the percentage reached (-12.87%). The emitters for both water inferred that less clogging ratio than organic matter and soil suspension is less than organic matter (O.M) and soil suspension (S.S). It is observed that clogging ratio in control was -9.727% whereas -19.241%, -11.728% for organic matter and soil suspension for LSI, however, LSII control was -8.1628%, -24.595% and -12.3088 for organic matter O.M) and Soil suspension (S.S) respectively. This reduction may be due to water properties such as contain $CaCO_3$. Besides, the course fraction of organic matter in water has a significant role in reducing the flow rate that could be precipitated after application and capable of closing the emitters easier. Also, colloidal fractions of humified organic matters that increase the negative charge in the water will expand its reactions with most cationic ions like Ca^{+2} mostly from $CaCO_3$ and creation of sizeable chelating compound, could make a large particle size and part of this colloidal are suspended solids hence increasing clogging ratio. This result was in agreement with (Qingsong et al. 2008). Another reason that organic fertilizers increase the clogging is the amount of calcium in it that will precipitate within narrow openings in the emitter after water evaporation mainly in the form of CO_3 and SO_4. Finally, the emitter clogging will increase with increasing the application of organic fertilizers leading to a decrease in the flow rate of applied water (Tayel, Mansour, and Pibars 2013)

Table (4): Initial and Final Flow Rates of Sumael Langelier Saturation Index (LSI) through drip Emitter's water flowing for a period of 320 hours

Periods	**Emitters**	Control			Organic Matter (O.M)			Soil Suspension (S.S)		
		Initial	Final	%Change	Initial	Final	%Change	Initial	Final	%Change
	1	2.1	1.992	-5.143	2.19	1.914	-12.603	2.16	1.986	-8.05556
40 hrs	2	2.1	1.956	-6.857	2.16	1.95	-9.7222	2.13	1.926	-9.57746
	3	2.04	1.854	-9.118	2.07	1.802	-12.947	2.04	1.842	-9.70588
	Average(%)			**-7.039**			**-11.757**			**-9.11297**
	1	2.1	2.052	-2.286	2.19	2.064	-5.7534	2.16	2	-7.4074
80 hrs	2	2.1	1.944	-7.429	2.16	1.92	-11.111	2.13	1.872	-12.1127
	3	2.04	1.782	-12.647	2.07	1.596	-22.899	2.04	1.758	-13.8235
	Average(%)			**-7.454**			**-13.254**			**-11.1145**
	1	2.1	1.95	-7.143	2.19	1.892	-13.607	2.16	1.932	-10.5556
120 hrs	2	2.1	1.812	-13.714	2.16	1.832	-15.185	2.13	1.842	-13.5211
	3	2.04	1.886	-7.549	2.07	1.772	-14.396	2.04	1.818	-10.8824
	Average(%)			**-9.4687**			**-14.721**			**-11.653**
	1	2.1	1.98	-5.7143	2.19	1.968	-10.137	2.16	1.932	-10.5556
160 hrs	2	2.1	1.8	-14.286	2.16	1.929	-10.694	2.13	1.884	-11.5493
	3	2.04	1.822	-10.686	2.07	1.419	-31.449	2.04	1.77	-13.2353
	Average(%)			**-10.229**			**-17.396**			**-11.78**
	1	2.1	2.01	-4.286	2.19	2.058	-6.0274	2.16	1.956	-9.44444
200 hrs	2	2.1	1.806	-14.000	2.16	1.902	-11.944	2.13	1.818	-14.6479
	3	2.04	1.784	-12.549	2.07	1.23	-40.58	2.04	1.782	-12.6471
	Average(%)			**-10.259**			**-19.517**			**-12.246**
	1	2.1	1.938	-7.714	2.19	2.01	-8.2192	2.16	1.862	-13.796
240 hrs	2	2.1	1.866	-11.143	2.16	1.926	-10.833	2.13	1.89	-11.2676
	3	2.04	1.794	-12.059	2.07	0.948	-54.203	2.04	1.794	-12.0588
	Average(%)			**-10.305**			**-24.418**			**-12.3686**
	1	2.1	1.956	-6.857	2.19	1.962	-10.411	2.16	1.884	-12.7777
280 hrs	2	2.1	1.92	-8.571	2.16	1.92	-11.111	2.13	1.89	-11.2676

zeravan.ariff@uod.ac

	3	2.04	1.716	-15.882	2.07	0.954	-53.913	2.04	1.776	-12.9412
	Average (%)			**-10.437**			**-25.145**			**-12.3288**
	1	2.1	1.782	-15.143	2.19	1.974	-9.863	2.16	1.856	-14.074
320 hrs	2	2.1	1.956	-6.857	2.16	1.848	-14.444	2.13	1.872	-12.1127
	3	2.04	1.716	-15.882	2.07	0.852	-58.841	2.04	1.765	-13.4803
	%Average			**-12.627**			**-27.716**			**-13.2223**
Average(%) of (8) periods				**-9.7273**			**-19.241**			**-11.7282**

Table (5): Initial and Final Flow Rates of Bazalan Lonelier Saturation Index (LSII) through drip Emitter's water flowing for a period of 320 hours

Periods	**Emitters**	Control			Organic Matter (O.M)			Soi Suspension (S.S)		
		Initial	Final	% Change	Initial	Final	% Change	Initial	Final	% Change
	1	2.166	2.088	-3.601	2.16	2.004	-7.222	2.25	2.1	-6.667
40 hrs	2	2.112	2.004	-5.114	2.04	1.944	-4.706	2.16	2.022	-6.389
	3	2.082	1.89	-9.222	2.04	1.812	-11.176	2.1	1.764	-16.00
	Average (%)			**-5.979**			**-7.702**			**-9.685**
	1	2.166	2.052	-5.263	2.16	1.944	-10	2.25	2.034	-9.6
80 hrs	2	2.112	1.944	-7.955	2.04	1.92	-5.882	2.16	1.938	-10.278
	3	2.082	1.878	-9.798	2.04	1.848	-9.412	2.1	1.848	-12
	Average (%)			**-7.672**			**-8.431**			**-10.626**
	1	2.166	1.992	-8.033	2.16	2.046	-5.278	2.25	1.974	-12.267
120 hrs	2	2.112	1.944	-7.955	2.04	1.824	-10.588	2.16	1.932	-10.556
	3	2.082	1.914	-8.069	2.04	1.716	-15.882	2.1	1.824	-13.143
	Average (%)			**-8.019**			**-10.583**			**-11.988**
	1	2.166	1.986	-8.31	2.16	1.932	-10.556	2.25	2.052	-8.8
160 hrs	2	2.112	1.95	-7.67	2.04	1.848	-9.412	2.16	2.01	-6.944
	3	2.082	1.902	-8.646	2.04	1.776	-12.941	2.1	1.65	-21.429
	Average (%)			**-8.209**			**-10.969**			**-12.391**
	1	2.166	2.064	-4.709	2.16	2.106	-2.5	2.25	2.076	-7.733
200 hrs	2	2.112	1.902	-9.943	2.04	1.89	-7.353	2.16	1.956	-9.444
	3	2.082	1.86	-10.663	2.04	0.798	-60.882	2.1	1.65	-21.429
	Average (%)			**-8.438**			**-23.578**			**-12.869**
	1	2.166	1.962	-9.418	2.16	1.641	-24.028	2.25	2.058	-8.533
240 hrs	2	2.112	1.95	-7.67	2.04	1.467	-28.088	2.16	1.992	-7.778
	3	2.082	1.896	-8.933	2.04	0.974	-52.279	2.1	1.602	-23.714
	Average (%)			**-8.674**			**-34.798**			**-13.342**
	1	2.166	1.992	-8.033	2.16	2.094	-3.056	2.25	2.16	-4.00
280 hrs	2	2.112	1.926	-8.807	2.04	1.8	-11.765	2.16	1.962	-9.167
	3	2.082	1.872	-10.086	2.04	0.03	-98.529	2.1	1.524	-27.429
	Average (%)			**-8.976**			**-37.783**			**-13.532**
	1	2.166	1.956	-9.695	2.16	1.434	-33.611	2.25	2.028	-9.867

zeravan.ariff@uod.ac

320 hrs	2	2.112	1.92	-9.091	2.04	0.9	-55.882	2.16	1.914	-11.389
	3	2.082	1.89	-9.222	2.04	0.015	-99.265	2.1	1.662	-20.857
Average (%)				**-9.336**			**-62.919**			**-14.038**
Average (%) of (8) periods				**-8.162**			**-24.595**			**-12.309**

Dynamic Change for the Outflow of Clogging Ratios

In general, the change in clogging percentages were different according to the local materials applications compared to control. The definition of clogging depends on the ratio of clogging predominantly; a single emitter was considered unclogged if its flow rate was greater than 95% of the initial flow, in the case for slightly clogged was 80-95%, and 50-80% was identified as generally clogged, while for seriously clogged the ratio was between 20-50% finally less than 20% the emitter considered as completely clogged Wu et al. (2008). Table (6) and (7) inferred the emitter clogging ratio for each period time for Sumael and Bazalan water respectively. Essentially, the clogging ratio appeared gradually for both waters qualities then escalated with time. Mostly the organic matter application for LSII was more severe than all other treatments. Clogging ratio appeared after 40 hrs for all treatments with different ratios, started with control the ratios of clogging for Sumael water was 9.751to 16.355%. Over the period of 320 hrs the clogging ratio increased 6.604%. Whereas the ratio recorded for LSII was smaller than LSI, it was between 6.132 % after 40 hrs and become 9.340%. Consequently, over the period of 320 hrs the ratio of clogging reduced to half 3.208%. These could be due to the fact that Sumael water contains more bicarbonate and chloride than Bazalan water, lead to making reaction with Ca^{+2} and forming $CaHCO_3$ and Mg^{+2} with Cl^- to create the salt $MgCl_2$, these two salts are more susceptible to increase the clogging ratio. Organic matter treatment has high clogging potential in respect to control, but the clogging capacity appeared more in LSII. The most notable values arose after 200 hrs of irrigation, where the clogging ratio for LSI was 22.586% and increased to 26.885% over 320 hrs. In comparison, this ratio was found bigger in LSII, it was 15.865 to 36.538%. The clogging ratio as comparing to the first period for Sumael water increased 15.561% over the period 320 hrs. In contrast, this ratio was more evident for Bazalan water (LSII) when the ratio increased double compared to Sumael water and was 30.406 %. The ratios for S.S found in LSI to be greater than in LSII. In general, there was a progressive decrease in the flow rate of emitters and the reduction in clogging ratio appeared after 40 hrs of continuous irrigation for both water (LSI and LSII). The most fluctuations for soil suspension of flow rates were appeared over time with both water qualities (LSI) and (LSII), the greater sensitivity to clogging where the most significant with Sumael water (LSI) was 9.813 to 15.389% over the 320 hr. While in Bazalan water (LSII) the clogging ratio respect to control was 8.057 to 11.754%. This can be explained that the texture of the soil is silty clay which means the soil is containing higher clay percentage and was 47.6% clay content, the clogging of drippers may be due to the existence of montmorillonite in clay fraction in high concentration and it has been identified that montmorillonite consider as expandable minerals and swelling with water. The reason may be due to suspending solids will accumulate and gather or stick to the out-edge of the emitters, indicating that this emitter will become clogged as particle size and concentration of suspending colloidal (Qingsong et al. 2008). Also, it can be due to the concentration and diameter of soil particles, the interaction between these two factors has an effect on dripper performance between the gatherings, the same study was achieved by Oliveira et al., (2017).

.

zeravan.ariff@uod.ac

Table (6): Emitter clogging ratio for each time period and % change for applied local materials (Organic Matter and Soil Suspension) concerning respect control treatment under Sumael water quality (LSI)

Periods	Clogging Ratio (%)								
	Control	Clogging ratio % respect to 40hr	% Change	Organic Matter respect to control	Clogging ratio to 40hr	% Change	Soil Suspension respect to control	Clogging ratio % respect to 40hr	% Change
40 hrs	9.751	0.000	0.000	11.324	1.573	1.573	9.813	0.062	0.062
80 hrs	10.530	0.779	0.779	12.944	1.620	0.047	11.838	2.025	1.963
120 hrs	10.748	0.997	0.218	14.766	3.442	1.822	11.963	2.150	0.125
160 hrs	11.371	1.620	0.623	15.841	4.517	1.075	12.617	2.804	0.654
200 hrs	11.682	1.931	0.312	22.586	11.262	6.745	12.710	2.897	0.093
240 hrs	12.617	2.866	0.935	23.178	11.854	0.592	12.991	3.178	0.280
280 hrs	14.860	5.109	2.243	24.206	12.882	1.028	14.813	5.000	1.822
320 hrs	16.355	6.604	1.495	26.885	15.561	2.679	15.389	5.576	0.576
Total	**97.913**	**19.907**	**6.604**	**151.729**	**62.710**	**15.561**	**102.134**	**23.692**	**5.575**
Aver.	**12.239**	**2.488**	**0.826**	**18.966**	**7.839**	**1.945**	**12.767**	**2.961**	**0.696**

zeravan.ariff@uod.ac

Table (7): Emitter clogging ratio for each time period and % change for applied local materials (Organic Matter and Soil Suspension) respect to control treatment under Bazalan water quality (LSII)

Periods	Clogging Ratio (%)								
	Control	Clogging ratio % respect to 40hr	% Change	Organic Matter respect to control	Clogging ratio respect to 40hr	% Change	Soil Suspension respect to control	Clogging ratio % respect to 40hr	% Change
40 hrs	6.132	0.000	0.000	15.865	9.733	9.733	8.057	1.925	1.925
80 hrs	8.113	1.981	1.981	19.856	13.724	11.587	8.246	2.114	0.190
120 hrs	8.208	2.075	0.094	22.981	16.849	3.125	9.479	3.347	1.232
160 hrs	8.208	2.075	0.000	25.144	19.012	2.163	10.237	4.105	0.758
200 hrs	8.396	2.264	0.189	25.962	19.829	0.817	10.521	4.389	0.284
240 hrs	8.679	2.547	0.283	33.570	27.438	7.608	10.806	4.674	0.284
280 hrs	8.962	2.830	0.283	34.615	28.483	1.046	11.469	5.337	0.664
320 hrs	9.340	3.208	0.377	36.538	30.406	1.923	11.754	5.621	0.284
Total	**66.038**	**16.981**	**3.208**	**214.531**	**165.474**	**38.002**	**80.569**	**31.512**	**5.622**
Average	**8.255**	**2.123**	**0.401**	**26.816**	**20.684**	**4.750**	**10.071**	**3.939**	**0.703**

zeravan.ariff@uod.ac

Cumulative Clogging Ratio in Relation with Time

The Cumulative clogging ratio are plotted in Figs. (5) and (6) as a function of time for both water LSI and LSII respectively. The distribution of emitter clogging was affected by time for both water qualities, where the application of added materials has a great role to reduce the flow rate of emitters. While the system was in operating the clogging ratio developed with time, this Cumulative increase appeared gradually inside the flow path. Over 320 hrs of operating the system, it is verified that composition of application materials is the key to understanding the clogging ratio. Organic matter application for Sumael water (LSI) increases 154.37% compared to control was 104.86%. This means the organic matter reduced the discharge rate to 47.21%. Hence, the Cumulative clogging for S.S was 139.100 and decreased the discharge ratio to 32.65% as compared to control. As affected by the time for Sumael water (LSI) the Cumulative clogging ratio for organic matter appeared after 240 hrs of continued irrigation and reach 101.250%, then the ratio started to raise up to the maximum value over 320 hrs of operating system. Similar to the S.S, the clogging ratio was increased to 96.63% after passing 240 hrs of continued irrigation. In Bazalan water (LSII) for organic matter application, the reduction in emitter discharge was more noticeable related to control. Whereas the value recorded in control as Cumulative CR% was 66.038% corresponding to organic matter was 204.65%. In addition, S.S reduced the discharge of emitters to 22.0%. This study appeared that the interaction between addition of local materials (organic matter, soil suspension) and water quality has strong relation to the water properties, especially the result was more obvious with organic matter application in Bazalan Water (LSII). The high concentration of Ca^{+2} ions in Bazalan water (LSII) might react with humid colloidal in organic matter, raising the negative charge, and producing $CaCO_3$, which has a significant role in precipitating on the drippers. The addition of organic fertilizers will increase emitter clogging, resulting in a decrease in the flow rate of applied water. (Tayel, Mansour, and Pibars 2013).

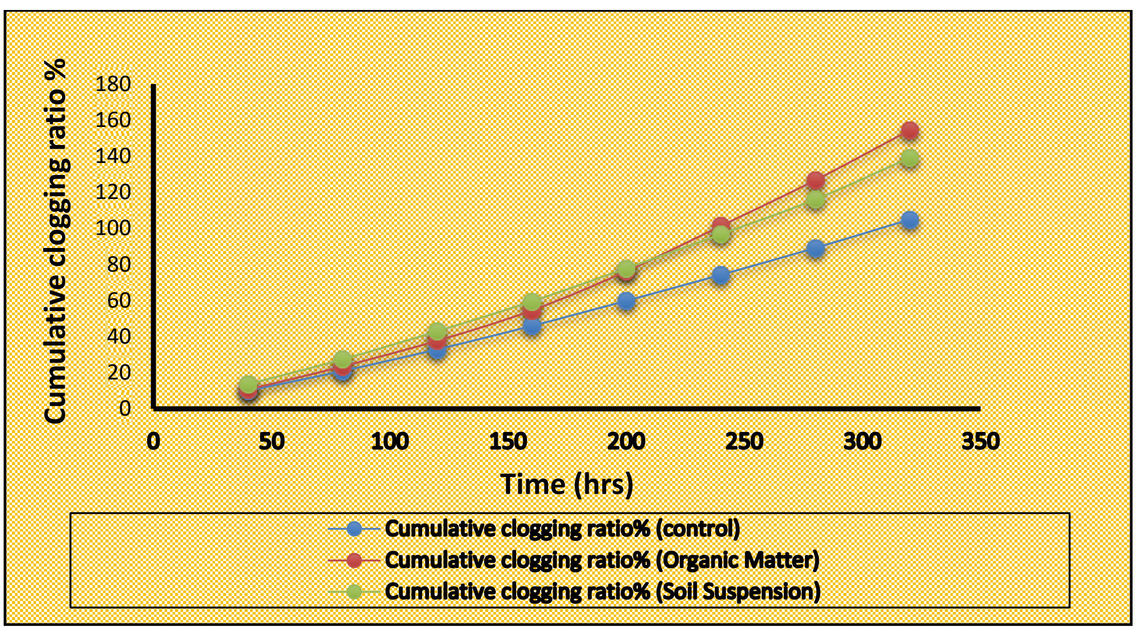

Fig. (5): Cumulative clogging ratios as a function of time for Sumael water (LSI)

zeravan.ariff@uod.ac

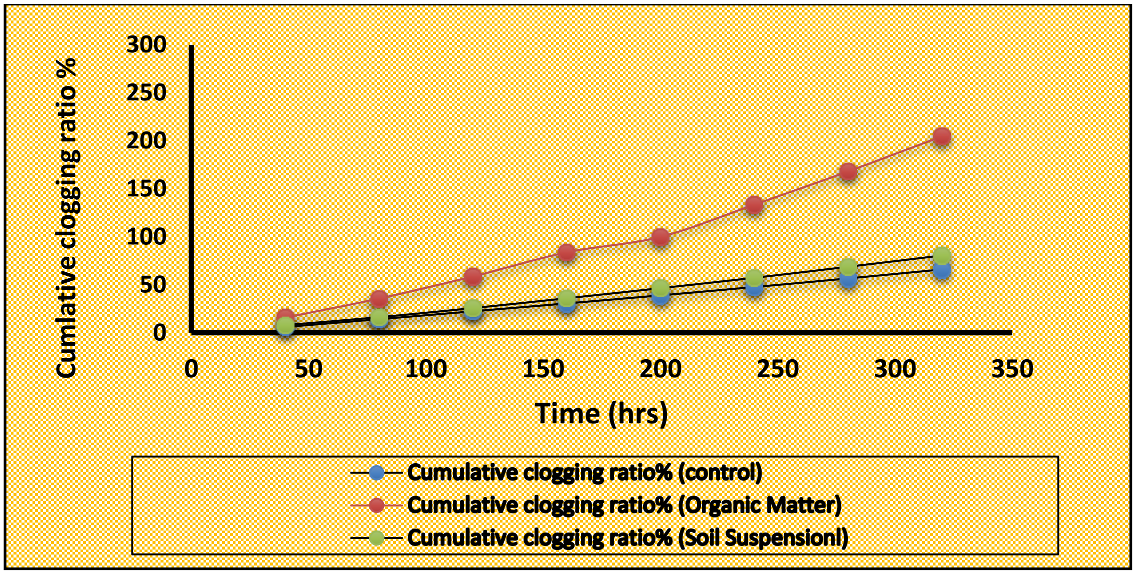

Fig.(6): Cumulative clogging ratios as a function of time for Bazalan water (LSII)

Evaluation Performance Parameter of Drip Irrigation

Volumetric method was used to measure the discharge of dripper under the pressure of one bar. To evaluate the emitter's performance test, the discharge of fresh emitter was measured before application of local materials. Yavuz *et al.*, (2010) the performance indicators used to assess drip irrigation system were coefficient of variation (C.V), emission uniformity (EU) and statistical uniformity (US). The performance parameters indicators used to estimate the drip irrigation system are flow rate (q) statistical uniformity (Us), emitter clogging ratio (CR), mean discharge Ratio (Dra), and Christiansen's uniformity coefficient (CU). Table (8) and (9) shows the performance of uniformity parameters values using local materials organic matter and soil suspension compared with control for two water qualities (LSI) and (LSII) respectively. Two lateral lines were used for each treatment and have 20 emitters. Among all of them, 6 emitters were taken to measure the flow rate. There were variations between uniformity parameter for all treatments. The flow rate shows slightly variations over time, but this difference was more obvious with application of organic matter and soil suspension compared to control. Water quality has a great effect on emitter flow rate, where the emitter discharge was 1.931 L/hr as average for 40 hrs and reduced to 1.790 L/hr for 320 hrs for Sumael water (LSI). Otherwise to the Bazaln water (LSII) the flow rate for 40 hrs was 1.99 L/hr and become 1.922 L/hr after 320 hrs. The reduction in flow rate for organic matter application for Bazalan water (LSII) was more noticeable than Sumael water (LSI), where the flow rate was reduced from 1.75 L/hr to 1.32 L/hr while for Sumael water (LSI) reduced from 1.898 L/hr to 1.565 L/hr over 320hrs.

The flow rate for application of soil suspension for Sumael water (LSI) was more exposed to clogging. The discharge rate was 1.898 L/hr after 40hrs and become 1.811 L/hr during a period of 320 hr. In contrast, Bazalan water shows slightly variations started from 1.94 L/hr to 1.862 L/hr. 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 found lower for Bazalan (LSII) and ranged between 0.059 and 0.062. According to ASABE (2003), the criteria for coefficient variation (CV) of drippers was classified excellent when the value was less than 0.05 for point source drip. The clogging ratio potential for LSII was less than in LSI for control while organic matter is more response to clogging ratio. Soil suspension appeared to severe clogging ratio in LSI than in LSII. This could be explained that high concentration of chloride ions in addition

zeravan.ariff@uod.ac

soil and Sumael water (LSI), contain higher concentration of chloride than in Bazalan water (LSII) lead to form $MgCl_2$ salts and increase clogging potential. The application of different materials has no completely physical clogging of emitter. In general, over the time the clogging ratio started to increase for both water qualities including all treatments. The variations of clogging ratios were appeared after 160 hrs and escalated to reach 320 hrs. Among all treatment clogging ratio potential was more obvious in organic matter application for both water qualities. The most distinct ratio was for the Bazalan (LSII) after 320 hrs reached to 36.538 % and 26.885% for Sumael water (LSI). This may be due to organic materials, which increase negative charge in water and the response with most of other cationic. It creates large particles in size with other suspended materials; and leads to increase the clogging potentials. As high concentrations of cations ratios for Bazalan water compared to Sumael, the clogging ratio potential for Bazalan increased. Wu et al. (2008) defined the clogging ratio depending on the flow rate for the single emitter is considered unclogged if the outflow is more than 95 % of the initial flow, and 80-95% classified as slightly clogged. Generally clogged emitter is defined when the ratio is between 50-80% while 20-50% is considered as seriously clogged; 20% and less are considered as completely clogged. After 40 hrs of continued irrigation, the system outflow of emitters appeared to reduce and this reduction of emitter discharge increased for all treatment over time. Clogged emitters usually occurred at the end of season the clogging ratio for both water qualities (LSI and LSII) in general was considered slightly clogged. After 320 hours, Sumael water (LSI) Organic matter application was more susceptible to clogging ratio. Accounting for 26.885%, it is considered generally clogged and 15.389% for soil suspension classified slightly clogged. Severe clogging appeared for organic matter for Bazalan Water (LSII) when the clogging ratio became 33.570% after 240hrs then increased to 36.538% in 320 hrs. Whereas, the soil suspension accounted 11.75% over 320 hrs and classified as slightly clogged. Similar results obtained by (Pei et al. 2014) that between 216-264 hrs severe and complete clogging happed. The criteria for statistical uniformity of emitters Us was classified by ASABE (1994) when Us ranged between 95 and 100 %. It is classified perfect, 80 to 90% categorized good, 75 to 80% is Tolerable, 65 to70% taken to be very bad and below 60% considered unacceptable. The uniformity parameters values in general for Sumael water (LSI) were perfect range. The highest value was for control after 40 hrs the value was 97.823% then over time; then the range reduced to 93.875% over 320 hrs. The Us values for organic matter application for the same water were low, ranging between 91.512 to78.037%, where the ranged deviate from good to tolerable. In contrast, the organic matter for Bazalan water were scale down from good to very bad, where the values ranged between 87.815% to 68.388%. While the soil suspension for Sumael water (LSI) were 92.703 after 40 hrs then reduced to 88.211% over 320 hrs. It means the range was remaining good. In compare to Bazalan water (LSII) Us values remain good, which the range was between 94.064% to 93.756% between 40 to 320 hrs. The uniformity coefficient (Cu) according to (ASAE) 2000, is classified as the following values: 90% or greater it can interpreted excellent, 80-90% very good, 70-80% fair, 60-70% poor, and less than 60% consider unacceptable. The formula of Christiansen's (1942) applied to calculate the uniformity of coefficient of emitters using three treatments for two water qualities Sumael (LSI) and Bazalan (LSII). The highest value of Cu was obtained for control ranged between 94.875 and 91.094%; 97.311% and 95.574% for both water Sumael (LSI) and Bazalan (LSII) respectively. Whereas, the values for organic matter after 40 hrs were 93.998% as height value and the lower value reduced to 84.470% for Sumael water (LSI). In contrast, organic matter in Bazalan water (LSII) the maximum value was 91.027% then after 320 hrs the value reduced to 77.306%. Soil suspension for Sumael water (LSI). At first, after 40 hrs it was 92.703% then reduced to 88.211% after 320 hrs. In contrast to the Bazalan water (LSII), the Cu values for soil suspension were the highest among all treatments used for both water qualities and it was between 94.064% after 40 hrs and then reduced to the range 93.92% after 320 hrs. According to the recommendations (ASAE) 2000, emitters for control of the two water qualities are considered excellent. Organic matter applications for Sumael (LSI) after 40 hrs was very good then after 320 hrs remained in the same range. Similarly, for Bazalan

zeravan.ariff@uod.ac

(LSII) after 40 hrs was also very good, but after 320 hrs it considered Tolerable. Soil suspension for Bazalan (LSII) was excellent category and changed to very good. Finally, Sumael water (LSI) ranged between excellent category over 320 hrs. The average relative discharge of drip irrigation emitters (Dazhuang, Peiling, and Yunkai 2011). The Dra expressed the degree of reduction in discharge flow rates. If the Dra value is less than 75%, the emitter is considered clogged (Zhangzhong et al. 2018). The characteristic of emitter clogging was also measured based on the variation in emitter discharge ratio (Dra %), it is declined over time as the operation system progressed. The values of (Dra%) for Sumael water (LSI) control treatment remain between 90.249 and 83.645% from 40 to 320 hours, respectively. While the same treatment for Bazalan water (LSII) values were between 93.868% and 90.660%. In contrast, the evident ranges between the values of organic matter were more obvious in Bazalan water (LSII) than in Sumael water (LSI). The fluctuated changes in Bazalan were reduced from 84.135% in 40 hrs to 63.462%. Whereas in Sumael (LSI), the variation where smaller than in Bazalan the value was 88.676% after 40 hrs decreased to 72.26%. The emitters for both water qualities were considered clogged after 320 hrs. Soil suspension for Sumael water (LSI), the values ranged for periods 40 to 320 hrs from 90.187 to 84.611, the Dra of emitters in Bazalan water fluctuated slightly the values measured after 40 hrs was 91.94% reduced to 88.24%. This may be attributed to the fact that water qualities have a main role to increase clogging ratio, particularly with using local treatments, Na+ has a great role to reduce clogging ratio as in Bazalan water and increase with organic matter with both water qualities.

Table (8): System uniformity parameters for Sumael water quality (LSI)

Water Quality	Periods	Performance parameter values					
Sumael (LSI)		**q L/hr**	**CV**	**CR%**	**Dra%**	**Cu%**	**Us%**
Control	40 hrs	1.931	0.022	9.751	90.249	94.875	97.823
	80 hrs	1.915	0.025	10.530	89.470	94.443	97.461
	120 hrs	1.910	0.026	10.748	89.252	94.321	97.355
	160 hrs	1.897	0.030	11.371	88.629	93.972	97.039
	200 hrs	1.890	0.031	11.682	88.318	93.797	96.875
	240 hrs	1.870	0.036	12.617	87.383	93.267	96.355
	280 hrs	1.822	0.051	14.860	85.140	91.974	94.944
	320 hrs	1.790	0.061	16.355	83.645	91.094	93.875
Organic Matter	40 hrs	1.898	0.085	11.324	88.676	93.998	91.512
	80 hrs	1.871	0.095	12.944	87.056	93.285	90.503
	120 hrs	1.824	0.113	14.766	85.234	92.028	88.726
	160 hrs	1.801	0.102	15.841	84.159	91.398	89.833
	200 hrs	1.657	0.180	22.586	77.414	87.270	81.996
	240 hrs	1.644	0.185	23.178	76.822	86.892	81.463
	280 hrs	1.622	0.195	24.206	75.794	86.231	80.527
	320 hrs	1.565	0.220	26.885	73.115	84.470	78.037
Soil Suspension	40 hrs	1.898	0.072	9.813	90.187	94.007	92.703
	80 hrs	1.887	0.089	11.838	88.162	93.709	91.103
	120 hrs	1.884	0.090	11.963	88.037	93.638	91.003
	160 hrs	1.870	0.095	12.617	87.383	93.267	90.478
	200 hrs	1.868	0.096	12.710	87.290	93.214	90.403
	240 hrs	1.862	0.098	12.991	87.009	93.053	90.176
	280 hrs	1.823	0.113	14.813	85.187	92.001	88.688
	320 hrs	1.811	0.118	15.389	84.611	91.664	88.211

zeravan.ariff@uod.ac

Table (9): System uniformity parameters for Bazalan Water quality (LSII)

Water Quality		Performance parameter values					
Bazalan (LSII)	Periods	q L/hr	CV	CR%	Dra%	Cu%	Us%
Control	40 hrs	1.99	0.045	6.132	93.868	97.311	95.527
	80 hrs	1.948	0.060	8.113	91.887	96.245	94.021
	120 hrs	1.946	0.061	8.208	91.792	96.194	93.948
	160 hrs	1.946	0.061	8.208	91.792	96.194	93.948
	200 hrs	1.942	0.062	8.396	91.604	96.091	93.803
	240 hrs	1.936	0.045	8.679	91.321	95.937	95.464
	280 hrs	1.93	0.066	8.962	91.038	95.782	93.365
	320 hrs	1.922	0.069	9.340	90.660	95.574	93.072
Organic Matter	40 hrs	1.75	0.122	15.865	84.135	91.027	87.815
	80 hrs	1.667	0.156	19.856	80.144	88.623	84.412
	120 hrs	1.602	0.184	22.981	77.019	86.665	81.641
	160 hrs	1.557	0.203	25.144	74.856	85.268	79.664
	200 hrs	1.54	0.210	25.962	72.986	84.731	78.904
	240 hrs	1.381	0.285	33.570	65.486	79.485	71.475
	280 hrs	1.36	0.296	34.615	64.455	78.726	70.400
	320 hrs	1.32	0.316	36.538	63.462	77.306	68.388
Soil Suspension	40 hrs	1.94	0.059	8.057	91.943	96.040	94.064
	80 hrs	1.936	0.061	8.246	91.754	95.865	93.918
	120 hrs	1.91	0.070	9.479	90.521	95.191	92.964
	160 hrs	1.894	0.054	10.237	89.763	94.771	94.605
	200 hrs	1.888	0.056	10.521	89.479	94.613	94.447
	240 hrs	1.882	0.057	10.806	89.194	94.454	94.289
	280 hrs	1.868	0.061	11.469	88.531	94.082	93.917
	320 hrs	1.862	0.062	11.754	88.246	93.922	93.756

Statistical Analysis of Parameters Uniformity

The statistical analysis of uniformity parameters was presented in Table (10). It was observed that there was a significant effect of Applied Local Material (ALM) on CR%, while the effect of water quality on CR% was found to be non- significant, higher CR% value (23.175%) was found under O.M treatment compared to other treatments, but the differences between control and SS was not significant. Concerning the interaction effect, the interaction effect between water and ALM was found to be significant. and showed that the value of CR was significant between both types of WQ only when applying O.M and the value of CR was significantly higher under LSII than LSI.//////Water quality (LSI) showed significant differences and higher US value (90.298%) than water quality (LSII) with mean of (88.629%). US was also revealed same trend by ALM, and significantly greater amount of US was observed under control (95.14%) and SS (91.99%) compared to O.M (81.26%). The interaction between WQ and ALM was also found to be significantly affected US. This interaction showed that at LS1 the value of US was only significantly higher at control compared to O.M, while at LSII water quality the US value was significantly increased at both control and SS compared to O.M. Cu was significantly affected by ALM but there was no significant effect of WQ on Cu, higher amount of CU was recorded at both control (94.68%) and SS (94.03%) in comparison with O.M (86.5%). On the other hand, the interaction effect between ALM and WQ was found to be significant. The interaction indicated that the amount of Cu was significant between LSI and LSII only under O.M and higher value of Cu was observed when LSI applied compared to LSII. The statically analysis revealed that there was a significant difference in discharge rate between WQ treatments. Larger discharge rate was observed under LSI compared to LSII with mean values 1.816 and 1.787 respectively. Discharge rate was also found to be significantly affected by ALM and larger discharge was observed under both control and SS compared to O.M with mean values of 1.906, 1.867, and 1.622 respectively.

zeravan.ariff@uod.ac

Concerning to interaction, it was found that there was significant in discharge rate between LSI and LSII only in case of applying O.M. to LSI significantly increase the discharge rate compared to LSII, while there is not significant effect of other types of ALM on discharge rate under both types of WQ. Similar to Cu, there was a significant effect of ALM on Dra, while effect of WQ on Dra was observed to be non-significant. Higher values of Dra were observed under control (89.51%) and SS (88.28%) compared to O.M (76.62%). The interaction effect between WQ and ALM on Dra was also found to be significant. This interaction effect showed that the effect of WQ on Dra was significant only when applying O.M and Dra value was significantly higher under LSI than LSII with mean value of 80.343 and 72.916% for both LSI and LSII under O.M respectively.

Table (10): Effect of water quality and applied local materials on emitter clogging ratio%

Water	**Applied Local Material**			**Mean**	**Water**	**Applied Local Material**			**Mean**
Quality	**Control**	**O.M**	**S.S**		**Quality**	**Control**	**O.M**	**S.S**	
	CR%					**Us%**			
LS I	12.613	19.657	13.192	15.154	LS I	96.237	84.653	90.004	90.298
LS II	8.354	26.692	10.242	15.096	LS II	94.041	77.869	93.977	88.629
Mean	10.484	23.175	11.717		Mean	95.139	81.261	91.991	
LSD(0.05)	WQ n.s	ALM 4.53	Inter. 6.40		LSD(0.05)	WQ 1.514	ALM 4.585	Inter. 6.485	
	Cu%					**Discharge rate**			
LS I	93.253	88.991	93.283	91.842	LS I	1.870	1.719	1.861	1.816
LS II	96.112	84.002	94.771	91.628	LS II	1.943	1.525	1.894	1.787
Mean	94.682	86.497	94.027		Mean	1.906	1.622	1.876	
LSD(0.05)	WQ n s	ALM 2.969	Inter. 4.199		LSD (0.05)	WQ 0.024	ALM 0.094	Inter. 0.132	
		Dra%							
	LS I	87.387	80.343	87.435	85.055				
	LS II	91.646	72.916	89.758	84.773				
	Mean	89.516	76.629	88.283					
	LSD (0.05)	WQ n.s	ALM 4.459	Inter. 6.306					

water quality LSI (Sumael water), LSII (Bazalan water), b= treatments (O.M organic matter, S.S soil suspension)

CONCLUSIONS

From Current study it could be concluded the following points:

1-Field data denoted that application of organic matter with water could remarkably reduce the discharge rate for Bazalan water more than Sumael, due to high concentration of Ca^{+2} and Mg^{+2} ions in Bazalan than in Sumael.

2-The performance parameters of emitters under application of both organic matter and soil suspensions is in sufficient terms for emitter discharge efficiency (CR), manufacturing variation Coefficient (CV), emission uniformity (Eu), and statistical uniformity (Us).

3-Organic matter could be applied as solution with less quantities and continued during the seasons with that content low concentration of Ca^{+2}, with low quantity. Soil suspension application has a great role to increase the clogging ratio soil particle size and sediment concentration could be the main factors to reduce the discharge rate.

zeravan.ariff@uod.ac

REFERENCES

ASAE standards, 2000. Field evaluation of microirrigation systems (EP458), PP. 918-924

ASAE, S. (2008). Method of determining and expressing fineness of feed materials by sieving.

ASAE. 1994. “Design and Installation of Microirrigation Systems.” In ASAE EP405.1 Dec. 93, , 724–27.

ASAE. 2002. “Design and Installation of Microirrigation Systems.” ASAE EP405.1 Dec.01: 903–7.

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

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

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

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

Gearing, D. P., Comeau, M. R., Friend, D. J., Gimpel, S. D., Thut, C. J., McGourty, J., ... & Cosman, D. (1992). The IL-6 Signal Transducer, gp130: an Pncostatin M Receptor and Affinity Converter for the LIF Receptor. Science, 255(5050), 1434-1437.

Hillel, D. (2003). Introduction to environmental soil physics. Elsevier.

Keller, J., & Bliesner, R. D. (1990). Sprinkle and trickle irrigation.

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

Korukçu, A. (1980). Damla sulamasında yan boru uzunluklarının saptanması üzerinde bir araştırma. AÜ Ziraat Fakültesi Yayınları, 742.

Liu, H. S., Li, Y. K., Liu, Y. Z., Yang, P. L., Ren, S. M., Wei, R. J., & Xu, H. B. (2010). Flow characteristics in energy dissipation units of labyrinth path in the drip irrigation emitters with DPIV technology. Journal of Hydrodynamics, Ser. B, 22(1), 137-145.

Nakayama, F. S., & Bucks, D. A. (1991). Water quality in drip/trickle irrigation: a review. Irrigation science, 12(4), 187-192maintenance. Agricultural Water Management, 2(2), 149-162.

Niu, W., Liu, L., & Chen, X. (2013). Influence of fine particle size and concentration on the clogging of labyrinth emitters. Irrigation Science, 31(4), 545-555.

Oliveira, F. C., Lavanholi, R., de Camargo, A. P., Frizzone, J. A., Mouheb, N. A., Tomas, S., & Molle, B. (2017). Influence of concentration and type of clay particles on dripper clogging. Irrigation & Drainage Systems Engineering, 6(1), 5.

Pei, Y., Li, Y., Liu, Y., Zhou, B., Shi, Z., & Jiang, Y. (2014). Eight emitters clogging characteristics and its suitability under on-site reclaimed water drip irrigation. irrigation science, 32(2), 141-157.

Pescod, M. B. (1992). Wastewater treatment and use in agriculture-FAO irrigation and drainage paper 47. Food and Agriculture Organization of the United Nations, Rome.

Plugging, C. O. E. (1990). Causes and Prevention of Emitter Plugging In Microirrigation Systems1.

Qian, Y. B. (2002). Study on new technology of water-saving agriculture. Yellow River Conservancy Press, Zhengzhou.

Qingsong, W., Gang, L., Jie, L., Yusheng, S., Wenchu, D., & 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), 294-303.

Schwankl, L., & McGourty, G. (1992). Before-and-after tests on emitters show organic fertilizers can be injected through low-volume irrigation systems. California Agriculture, 46(5), 21-23.

zeravan.ariff@uod.ac

Schwankl, L., & McGourty, G. (1992). Before-and-after tests on emitters show organic fertilizers can be injected through low-volume irrigation systems. California Agriculture, 46(5), 21-23.

Tayel, M. Y., Mansour, H. A. G., & Pibars, S. K. (2013). Effect of closed circuits drip irrigation system and lateral lines length on growth, yield, quality and water use efficiency of soybean crop.

UCcedil, K. (2013). Elimination of lime causing clogging in emitters by chemical methods in drip irrigation. African journal of agricultural research, 8(13), 1136-1143

Wilcox, R. A., Deyoe, C. W., & Pfost, H. B. (1970). A method for determining and expressing the size of feed particles by sieving. Poultry Science, 49(1), 9-13.

Wei, H., Li, B., Li, J., Dong, S., & Wang, E. (2008). DNAzyme-based colorimetric sensing of lead (Pb2+) using unmodified gold nanoparticle probes. Nanotechnology, 19(9), 095501.

Wu, X.B., Wu, W.Y., Liu, H.L., Hao, Z.Y., Ma, Z.J., 2008. Experimental study on anti-clogging performance of emitters for reclaimed wastewater irrigation. Trans. CSAE 24 (5), 61–64, in Chinese with English abstract.

Yan, D., Yang, P., Li, Y., & Ren, S. (2011). Evaluation of drip emitter clogging with reclaimed wastewater irrigation. Transactions of the Chinese Society of Agricultural Engineering, 27(5), 19-24.

Yavuz, M. Y., Demrel, K., Erken, O., Bahar, E., & Devecler, M. (2010). Emitter clogging and effects on drip irrigation systems performances. African Journal of Agricultural Research, 5(7), 532-538.

YILDIRIM, O., & APAYDIN, H. (1999). Damla Sulamada Lateral ve Manifold Boru Çaplarm ın Belirlenmesinde Grafiksel Yöntem. TARIM BILIMLERI DERGISI, 5(1), 24-32.

Zhengying, W., Yiping, T., Juying, W., & Bingheng, L. (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), 1-9Wu XB. 2006. China Agri-Cultural University, Beijing (in Chinese with English abstract) Experimental Study of Drip Irrigation System Anti-Clog-Ging Performance under Reclaimed Water Irrigation.

Zhangzhong, L., Yang, P., Zheng, W., Wang, C., Zhang, C., & Niu, M. (2018). Effects of drip irrigation models on chemical clogging under saline water use in Hetao District, China. Water, 10(3), 345.

zeravan.ariff@uod.ac