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EMITTER CLOGGING PERCENT AS AFFECTED BY DIFFERENT LEVELS OF IRRIGATION WATER QUALITY

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ABSTRACT: In this study a lateral line of Poly Ethylene (PE) with 45m long was used for testing three emitter types which were: long path, short path and pressure compensating emitters. The inner diameter of lateral was 16mm. Every lateral line contained 90 emitters of the same type with nominal flow rate (4 L/h) at 100 kPa of operating pressure. The spacing between laterals was 0.75m, and was 0.5m between emitters. The emitters were tested with three levels of irrigation water quality: Nile water, treated drainage water and drainage water under two filtration processes (sand filter only and sand plus a screen filters). The conducted experiments were carried out in the laboratory of Agricultural and Bio-Systems Engineering Department, Faculty of Agriculture, Menoufia University, in Shbin El kom, Egypt. The latitude and longitude of the experimental location were 30°33 ̀ 31 ̏ N and 31°00 ̀ 36 ̏ E, respectively. By the aid of operating time until the completely clogging occurred. The effect of all these Parameters were derived. Long path emitter recorded the highest values of the studied parameters, where the maximum emitter clogging percent were (47.44% at 880h, 47.3% at 780h and 48.6% at 680h) for the three degree of water quality. The increasing emitter clogging percent were (5.1, 6.1 and 7.1%) for the Nile water, treated drainage water and drainage water respectively. The other two tested emitter gave (8.5, 9.4 and 11.1%) and (7.2, 7.4 and 8.2%) for short path emitter and pressure compensating emitter respectively.

Key words: Emitter clogging percent; long path emitter, short path and pressure compensating emitters; water quality; filtration process; operating time and hydraulic parameters.

INTRODUCTION

Trickle Irrigation is a method of applying uniform and precise amount of water directly to the root zone of the plants as per the requirement, through emitters at frequent intervals over a long period of time, via pressure pipe network (Patil et.al, 2013).

The changing of distribution uniformity in drip irrigation system along lateral line ranged from 83.47% to 98.75% to 98.75%. The distribution uniformity decreased with higher pressure head (Aboamera, 2012).

Emitter clogging is related to irrigation water quality, which appears to be a function of suspended particles, chemical components, and micro-organism activity in the water, (Gilbert and Ford, 1986). As a result, the mentioned factors have a significant impact on the precautions that will be required to prevent emitter clogging. When wastewater is reused for irrigation, some clogging occurs as a result of micro-organism activity (Ould et al., 2007).

The causes of clogging differ based on emitter dimension (Ahmed et al., 2007) and positions in lateral. De Kreij et al. (2003) found that the tube emitter system with laminar flow suffers more severe clogging than the labyrinth system with turbulent flow, because laminar flow is predisposed to clogging. Capra and Scicolone (2004) found that vortex emitters are more sensitive to clogging than labyrinth emitters. Ravina et al. (1997) found that fast flow can limit the biological growth on the pipe wall and thus lower the risk of clogging. Emitters with high discharge rates clog less than those with low discharge rates over the same period and more clogged emitters are found at the tailing part than at the leading part of the drip lateral. Emitter clogging greatly reduces the water distribution uniformity in irrigated fields which negatively influences crop growth and yield. (Puig Bargues et al., 2005) Under conditions with optimized

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drip irrigation, all plants can receive approximately the same quantity of water. Clogging induces poor water distribution among the plants, which can result in either excess irrigation or deficient irrigation of the plants. Excess irrigation leads to deep percolation and consequent disadvantages, including higher energy costs, fertilizer leaching, drainage needs and groundwater contamination risk. Conversely, deficient irrigation from severe emitter clogging can limit plant growth or even cause plant death.

To prevent emitter clogging, some methods have been used on both experimental and on field scales. Filtering and flushing drip lines are simple and useful methods to prevent emitter clogging, particularly for physical clogging (Nakayama and Bucks, 1991). Filtering can prevent inorganic particles and organic materials suspended in water from entering the drip-irrigation system. Flushing drip lines can clear the inorganic and organic materials precipitated in emitter orifices and on the inside-wall of drip hoses out of the system. Chemical clogging can be controlled with acid injection, which can lower the pH value of irrigation water and thus prevent chemical precipitation. Biological clogging is quite difficult to control. Chlorination is one of the most common and efficient ways used to prevent and treat emitter clogging caused by algae and bacteria (Dehghanisanij et al., 2005). Zhang et al. (2007) studied the hydraulic performance of emitters with labyrinth channels and suggested several structural optimization schemes for the design of emitters with high anti-clogging capability.

The research aims to management drip irrigation system to reduce emitters clogging and evaluate the performance of the drip irrigation system based on irrigation water quality, emitter type and filtration process type. All the last items were studied to select the best emitter performance according to the operating time until the completely clogging occurred.

MATERIALS AND METHODS

Experimental site:

The experiment was carried out in the laboratory of Agricultural Engineering Department, Faculty of Agriculture, Menoufia University during 2018, 2019 in shbin El kom with latitude and longitude 30°33ˋ 31ˋˋ N and 31°00ˋ 36ˋˋ E. A drip irrigation system was constructed outdoors and was adjusted every irrigation event. The drip irrigation system was fitted by all the required devices that used in measuring both of factors and the affected parameters. These devices were: pressure gauge, sand filter, screen filter and control valves.

The system design and component selection to evaluate the hydraulic performance of drip irrigation system was integral to the delivering system that meets the requirement of the research with an efficient and reliable manner. The used drip irrigation system having the possibility of changing both of the studied irrigation water quality, emitters and the filtration system. The control head depends on the irrigation water resource which was a tank (1*1*1 m) with capacity of 1000 liter and three levels of irrigation water quality were used (Nile water, treated drainage water and drainage water). Main pipe made of galvanized iron which was located between tank outlet and pump inlet with inner diameter of 38.1 mm. The electric motor (1.36 kW) with a centrifugal pump was used for pumping water from the tank to the system, which it was connected with the sand filter on the first system of filtration and in the second control head depended on the sand and screen filters fitted together with the sub-main line, which was of pulley vinyl chloride (PVC) with 25.4mm diameter, 3m in length and connected with three different lateral lines for each type of irrigation water under the same conditions. A lateral line of 45m long has been used, which is made of Poly Ethylene (PE) for the three emitter types (long path emitter, short path emitter and pressure compensating emitter). The outer diameter of lateral was 16mm with φ13.6mm inlet diameter. Every lateral line was contained 90 emitters of the same type in each lateral line with nominal flow rates (4 L/h), which was installed on ground with zero slope at operating pressure of 100 kPa with 0.75m of lateral spacing, and 0.5m of emitter spacing as shown in

Fig.1. Tests were conducted to study the effect of different treatments on emitters clogging and system uniformity.

Three types of emitters commonly used in Egypt were selected for the experiment. Two of them were inline, denoted as short-path (turbulent flow path) emitter and pressure compensating emitter (PC). The third one, (long-path) was an online turbulent flow labyrinth emitter with nominal flow rates (4 L/h).

The following logarithm linear regression shows the characteristics of each emitter equation as shown in Table (1).

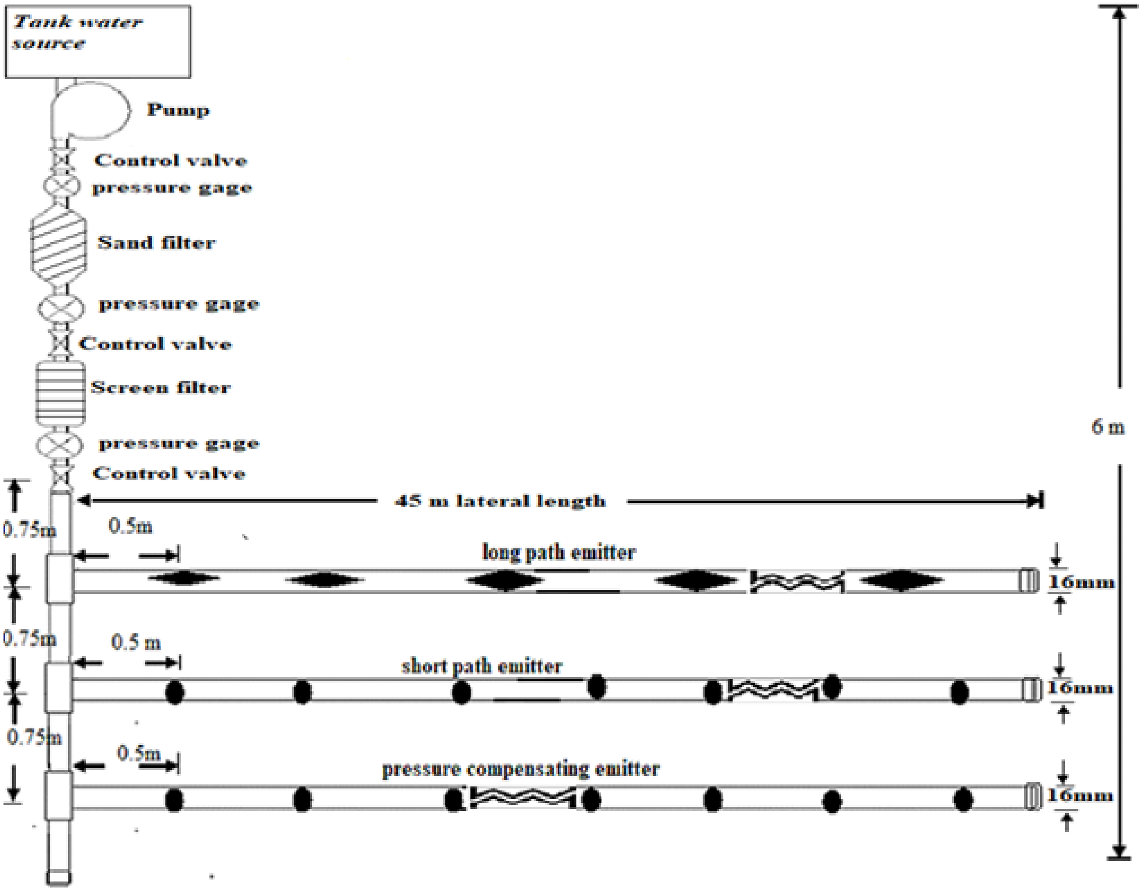

Fig. 1: Plan view of the experimental trickle irrigation system with the three emitter types.

Table (1): Emitter Characteristic and the relation between discharge and operating pressure.

Emitter Type	X- Value	K – Value	Equation	Flow Regime
Long path	0.69	Exp (0.1784) = 1.19	$q = 1.19\ H^{0.698}$	Mostly turbulent flow
Short path	0.49	Exp (0.25) = 1.28	$q = 1.28H^{0.4897}$	Fully turbulent flow
Pressure compensating	0.38	Exp(0.515) =1.53	$q = 1.53\ H^{0.38}$	Variable

Experimental treatments

The experimental study concerned with changing three emitter types and two filtration processes (the sand filter & the sand and screen filters). Three types of emitters were selected considering that they highly common used almost for all crops and three different flow paths and they have the same flowrate (4L/h). For each treatment, the system was operated at 100 kPa of the operating pressure. Each level of the irrigation water includes three treatments and each treatment contains a lateral line of 45m long. For all the tested treatments, the affected hydraulic parameters were computed with the aim of differentiation between the changing factors. The main hydraulic parameter was the percent of emitter clogging which will be computed according to the average value of emitter discharge for each treatment. For each treatment the system was operated 5h daily and the average value of emitter discharge was measured every 20 operating hours in order to follow the accumulation of clogging for each emitter type at the three levels of irrigation water with the two filtration processes.

Water type

Three different types of irrigation water were used to test its effect on emitter clogging and its chemical analyses shows in Table (2) which were: Nile water, drainage water and treated drainage water. The collected water samples were taken from September of 2018 to December 2019, which were The Nile water was collected from Talla canal, Menoufia Governorate. The treated drainage water was physically water treatment to the drainage water by mixing Nile water and drainage water with 1:1 ratio. The used drainage water was collected from Talla drain canal, Menoufia Governorate. For each type of irrigation water the system was operated 5h daily and the average value of emitter discharge was measured every 20 hours to follow the accumulation of clogging for each emitter type at each irrigation level.

Characteristic curves of the used emitters

The characteristics of the three tested types of emitters and the power regressions of each flow rate – pressure relationship were derived under 8 levels of the operating Pressure which where; (25, 50, 75, 100, 125, 150, 175 and 200 kPa) as shown in Fig. 2.

The logarithm equation distorted to exponential equation of 4 L/h emitters obtained showed that the flow regime of each emitter type was according to its exponent which were; 0.38, 0.49 and 0.698 referred to variable for pressure compensating emitter, fully turbulent for short path emitter and mostly turbulent flow for long path emitter, respectively.

Table (2): Chemical analysis of the used Nile, Drainage and Treated water.

Irrigation Water type	Cataions (meq/l)					Anaions (meq/l)				Total Dissolved Solids TDS (mg/l)	PH	Electrical Conductivity (EC) (ds.m^{-1})	Sodium Adsorption Ratio (SAR) (%)
	Calcium (Ca)	Magnesium(Mg)	Sodium (Na)	Potassium (K)	Sum	Sulphate So_4	Chloride (Cl)	Bicarbonate (Hco_3)	Sum				
Nile water	1.35	1.73	2.10	0.07	5.25	3.13	1.12	1.00	5.25	347.89	7.60	0.35	1.69
Drainage Water	2.43	4.20	13.10	0.21	19.94	8.86	8.30	3.00	20.16	1301.33	7.10	1.89	7.19
Treated drainage water	1.84	3.17	8.60	0.12	13.73	6.10	5.63	2.00	13.73	580	7.00	1.32	5.43

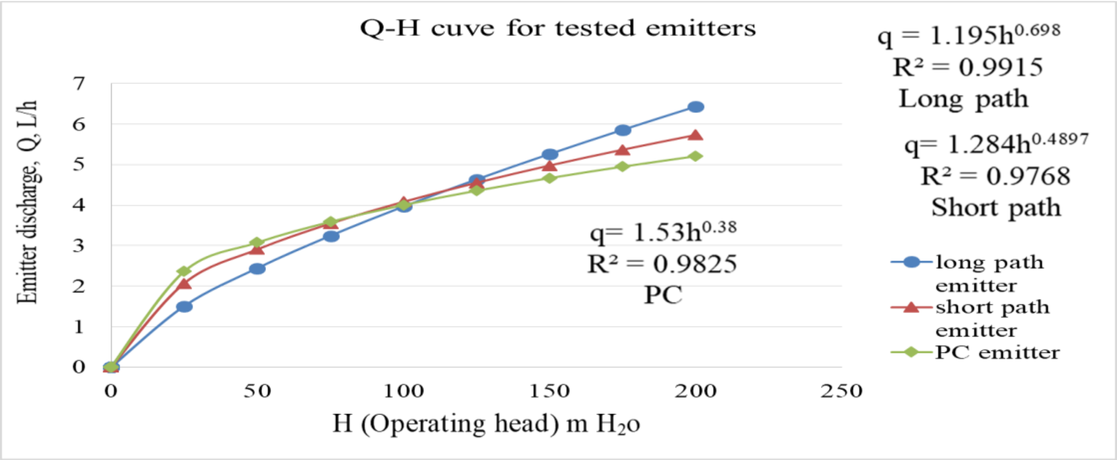

Fig. 2 Characteristics of each emitter type and its logarithm linear equation.

Emitter clogging percent

The value of clogging percent reflexes the role of both water quality and emitter type. It can be determined by the following equation:

$$P_{clog} = 100\left(1 - \frac{q_n}{q_c}\right) \qquad (1)$$

Where:

(P_{clog}) is the percentage of clogging emitters (%); and

(q_c) is the nominal discharge rate for each type of emitter (L/h).

Relative emitter discharge (R)

The relative emitter discharge (R) can be calculated using the following equation:

$$R = \frac{q_a}{q_{a\,ini}} \qquad (2)$$

Where, $q_a, q_{a\,ini}$ are the average emitter discharges of each lateral for each measurement and the corresponding average discharge of 90 new emitters at the same operating pressure of 100 kPa, respectively, L/h

Emission uniformity (EU)

The following formula was used to calculate emission uniformity (EU) as presented by (ASABE, 2008):

$$\mathrm{EU} = 100 \times \left(1 - \frac{1.27CV_m}{\sqrt{n}}\right)\frac{q_n}{q_a} \qquad (3)$$

Where:

EU is Emission Uniformity percent; and

(q_n) is the minimum flow rate of the sampling group emitters (L/h).

Uniformity Coefficient (UC)

Uniformity coefficient of water application can be expressed from the following equation (ASABE, 1999):

$$UC = 100 \times \left[1 - \frac{(\sum|q_i - q_a|)}{(n \times q_a)}\right] \qquad (4)$$

Where:

(UC) is Christiansen coefficient of uniformity %; and

(q_i) is the discharge rate of the emitter i (L/ h).

Distribution Uniformity (DU)

Low quarter distribution uniformity (DU) for all types of irrigation systems can be expressed (Marriam and Keller, 1978) as follows:

$$DU = 100 \times \frac{\sum q_{min}}{q_a} \qquad (5)$$

Where:

(DU) is distribution uniformity for low quarter (%); and

(q_{min}) is the average flow rate of the emitters in the lowest quartile (L/ h).

RESULTS AND DISCUSSIONS

Changing of emitter discharge

Although the three emitter types have the same nominal discharge with 4 L/h, the changing percent of emitter discharge differs for each emitter type, which was the charging percent of emitter discharge due to emitter type and by water quality level. The long path emitter has the least percent of emitter discharge variations at the three levels of irrigation water tested: Nile water, treated drainage water, and drainage water (20, 22 and 27%), short path emitter (32, 35 and 40%), and pressure compensating emitter (28, 31 and 27%) as shown in Table (3).

Tables (3): Variation of emitter discharge for the three types, with first filtration process for the three tested levels of water quality.

a) Long path emitter

Time	Variation of long path emitter discharge (L/h)		
T (h)	Nile	Treated	drainage
80	3.82	3.74	3.75
180	3.51	3.50	3.47
280	3.45	3.39	3.21
380	3.21	3.14	2.99
480	3.15	2.98	2.84
580	2.91	2.72	2.42
680	2.75	2.51	2.16
780	2.49	2.21	
880	2.25		
Changing percent (%)	20	22	27

b) Short path emitter

Time	Variation of short path emitter discharge (L/h)		
T (h)	Nile	Treated	Drainage
80	3.76	3.71	3.63
180	3.26	3.21	3.06
280	3.16	2.99	2.85
380	2.66	2.62	2.43
480	2.56	2.30	
580	2.16		
Changing percent (%)	32	35	40

c) Pressure compensating emitter

Time	Variation of pressure compensating emitter discharge (L/h)		
T (h)	Nile	treated	drainage
80	3.74	3.76	3.56
180	3.25	3.34	3.10
280	3.25	3.09	2.87
380	2.75	2.63	2.57
480	2.73	2.50	2.39
580	2.23	2.20	2.19
680	2.09		
Changing percent (%)	28	31	27

The obtained results as shown in Table (4) revealed that the second filtration process increased the operating time for the three emitter types with the three tested levels of irrigation water quality, where they were increased by (102, 77, and 74 %), (70, 83, and 79 %), and (44, 30 and 52%) for long path emitter, short path emitter, and long path emitter, respectively.

Comparing average discharge revealed that the operating time for long path emitter was increased with 45% for Nile water, 40% for treated drainage water, and 41% more than short path emitter and pressure compensating.

The changing percent of emitter discharge differs for each and the three degrees of water quality. For long path emitter, short path emitter, and pressure compensating emitter, respectively, Nile water, treated drainage water, and drainage water (10, 13 and 16%), (20, 21and 25%), and (18, 24 and 21%) as shown at Table (4). The changing percent values clarified that long path emitter had the lowest variation in the discharge than the other emitter types. Also the rate of change of emitter discharge in the second filtration process was lowest than the first filtration process.

Tables (4): Variation of emitter discharge for the three types, with second filtration process and the three tested levels of water quality.

a) Long path emitter

Time	Variation of long path emitter discharge (L/h)		
T (h)	Nile	Treated	drainage
80	3.84	3.83	3.85
180	3.78	3.75	3.77
280	3.90	3.76	3.65
380	3.80	3.59	3.53
480	3.88	3.62	3.46
580	3.74	3.44	3.28
680	3.77	3.45	3.19
780	3.59	3.21	2.92
880	3.63	3.18	2.77
980	3.45	2.88	2.48
1080	3.46	2.82	2.30
1180	3.22	2.52	2.12
1280	3.21	2.40	
1380	2.97	2.16	
1480	2.90		
1580	2.66		
1680	2.50		
1780	2.20		
Changing percent (%)	0.10	0.13	0.16

b) Short path emitter

Time	Variation of short path emitter discharge (L/h)		
T (h)	Nile	Treated	drainage
80	3.88	3.80	3.71
180	3.68	3.57	3.53
280	3.82	3.51	3.46
380	3.56	3.21	3.28
480	3.62	3.15	3.07
580	3.32	2.85	2.59
680	3.16	2.73	2.22
780	2.66	2.31	
880	2.46	2.13	
980	2.06		
Changing percent (%)	0.20	0.21	0.25

c) Pressure compensating emitter

Time	Variation of pressure compensating emitter discharge (L/h)		
T (h)	Nile	Treated	drainage
80	3.81	3.98	3.62
180	3.61	3.58	3.39
280	3.65	3.46	3.20
380	3.44	3.16	2.79
480	3.41	3.04	2.61
580	3.11	2.74	2.42
680	3.07	2.71	2.45
780	2.77	2.32	2.12
880	2.59	2.11	
980	2.15		
Changing percent (%)	0.18	0.23	0.21

Emitter clogging percent with the first filtration process (only sand filter)

Fig. 3 Showed that the effect of irrigation water quality on emitter clogging percent, with Nile water having the highest operation percent for the three emitter types by (13 and 29.4%), (21 and 53%), and about (17%) more than treated and drainage water with long path emitter, short path emitter, and pressure compensating emitter. For the three levels of water quality with long path emitter, the highest emitter clogging percent was (47.44% at 880 h, 47.3% at 780 h, and 48.6% at 680 h). The clogging emitter rate increased as water quality decreased, with (5.1, 6.1, and 7.1 %) for Nile water, treated drainage water, and drainage water with the long path emitter, (8.5, 9.4 and 11.1%), and (7.2, 7.4 and 8.2%) for short path emitter and pressure compensating emitter, respectively.

Fig. 4 shows that the relationship between the emitter clogging percent for three emitter types with operating time and the second filtration process. For the levels of water quality (Nile water, treated drainage water, and drainage water), the filtration process increased the operating time by (102, 77, and 74%), (70, 83, and 79%), and (44, 30 and 52%) for long path emitter, short path emitter, and pressure compensating emitter, respectively. The curves between emitter clogging percent and operating time in Fig. 4 have a liner relationship, and its equation has the slope, which is the rate of emitter clogging percent with operating time (0.03), (0.06), and (0.04, 0.06, and 0.051) for long path, short path, and pressure compensating emitter at the three levels of water quality.

Statistical analysis of filtration process and drainage water on emitter clogging percent

Table (5) shows the multiple comparisons of operation time mean per hour for different types of emitters. It shows highly significant difference between long path emitter and pressure compensating emitter (PC), meanwhile the difference between (PC) short path emitters was not significant.

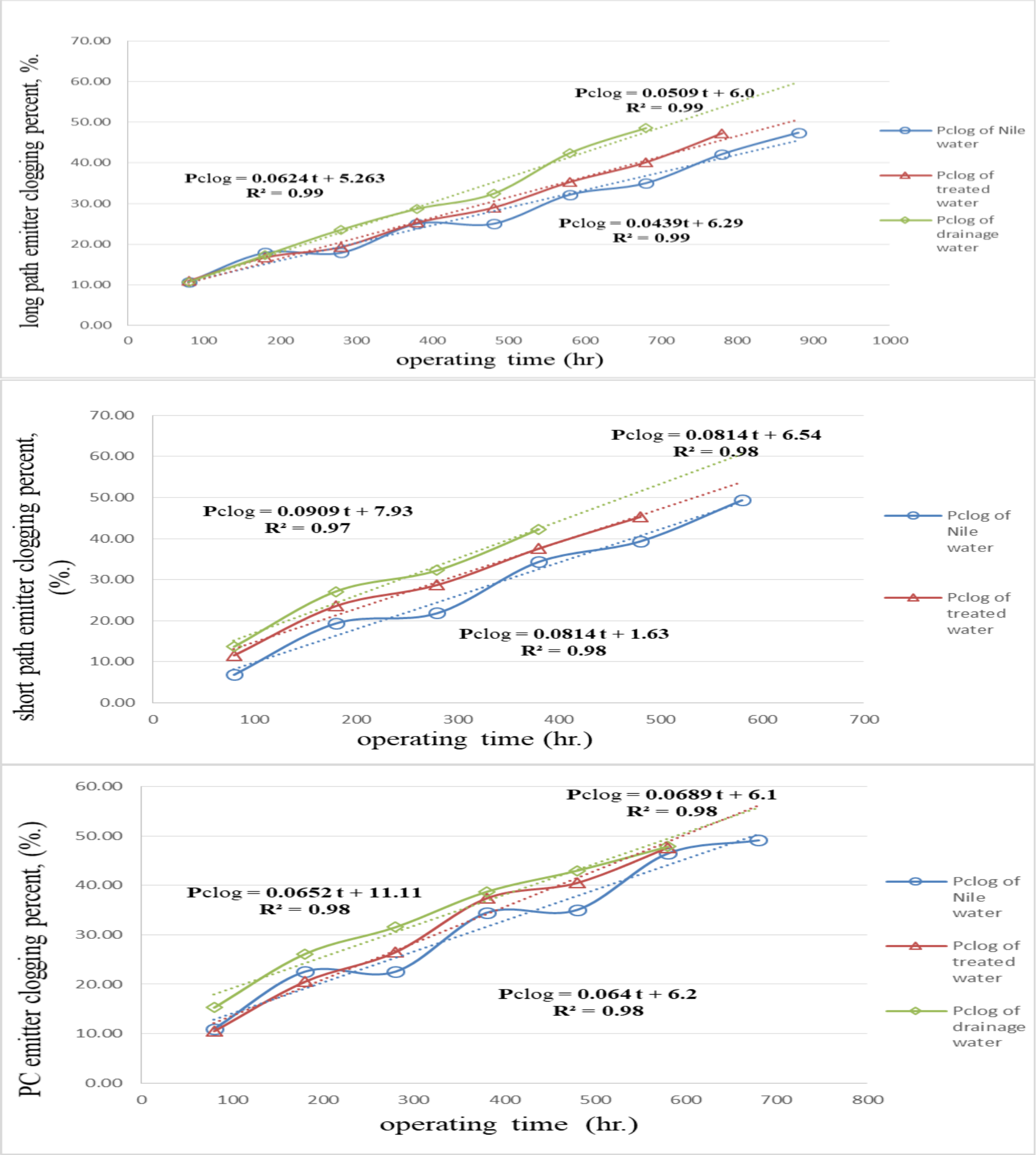

Fig. 3: Emitter clogging percent with operating time for the three emitter types and sand filter with irrigation water quality.

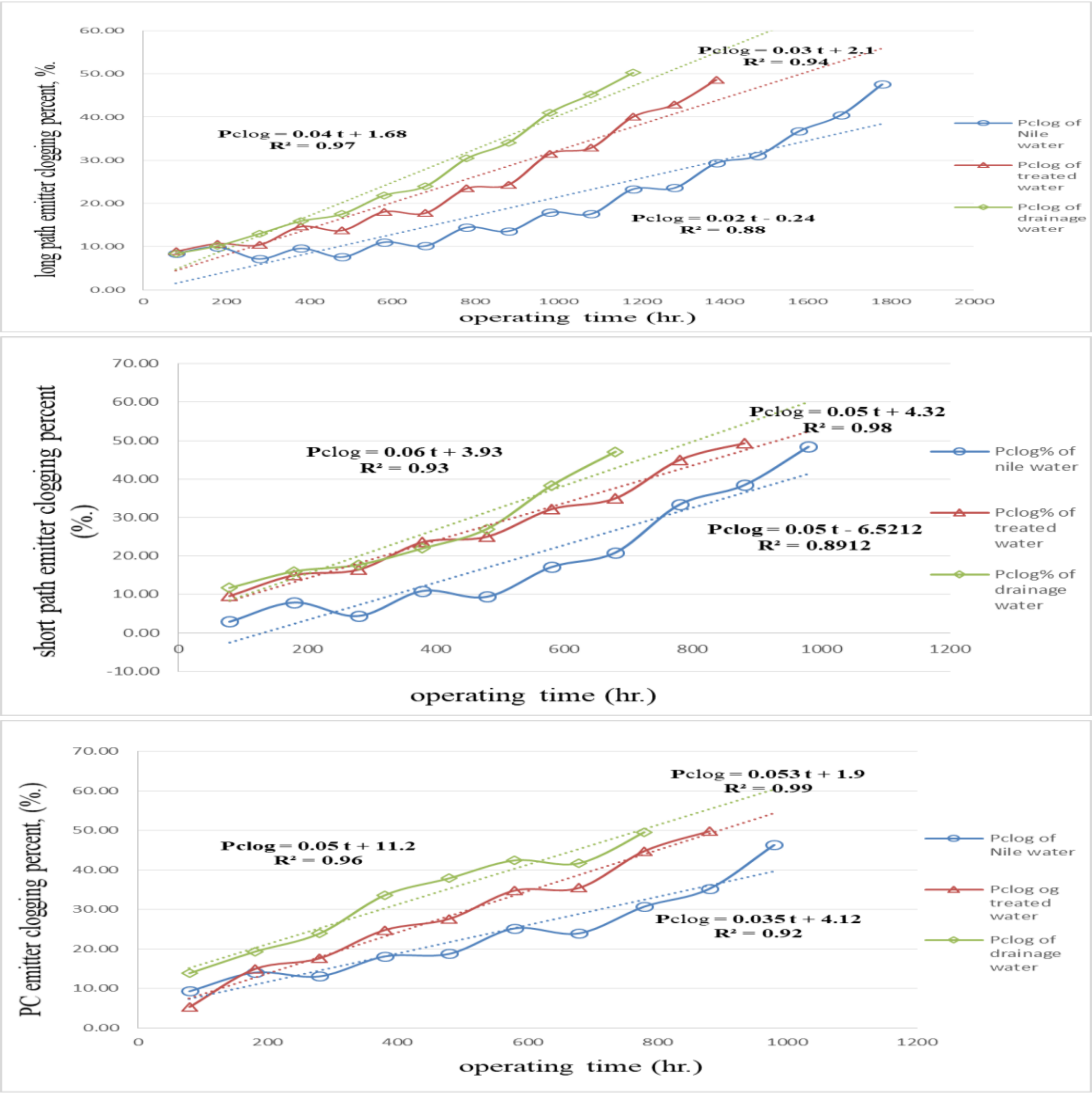

Fig. 4: Emitter clogging percent with operating time for the three emitter types and second filtration process for irrigation water quality.

Table (5): Multiple comparisons of operation time for different types of emitters using LSD value.

Dependent Variable	Emitter type (I)	Emitter type (J)	Mean Difference (I-J)
Operating time in h	Long path emitter	Short	265.35** H.S
		PC	238.45** H.S
	Short path emitter	Long	-265.35** S
		PC	(-26.90) N.S
	pressure compensating emitter (PC)	Long	-238.45** S
		Short	(26.9) N.S

Source: Results of statistical Analysis by Using SPSS Ver. 26
**: Highly Significant at 1% level of significance.
( ): Numbers between Brackets Are Not Significant.

Table (6) shows the conclusion of experiment results, it shows that the best treatment was the Nile water with the second filtration system through the long path emitter due to it has the highest operation time per hour. It's also shows that the treated drainage water at the second filtration system with long path emitter is higher than the drainage water at the same filtration system concerning the operation time. While as the difference between short path emitter and pressure compensating emitter at the second filtration system was not significant with all irrigation water types.

The Buckingham's-π method

Certain types of partial differential equations are solved using Buckingham's Pi theorem. it is based on dimensional analysis whose the main idea is to substitute a set of dimensionless numbers for the dimensional physical variable that described the dynamics of system, where m is the number of variables (8 variables, which are q, P, Ec, T, L, S, d and W) and n number of dimensional quantities (3 dimensional quantities, which are M, L, and T). In general it can be derived (m-n) independent dimensionless groups.

The emitter clogging percent (P_{clog}) was a function of the operating time of the irrigation system and derived as follows:

$$P_{CLOg}\% = f\left(E_c, T, L \big/ d, s, q\right) \qquad (6)$$

Where:

q: Emitter discharge according to flow path type (L/h),

P: operating pressure (kg/mT^2),

Ec: Electrical conductivity of the tested irrigation water (m gm/L),

T: Operating irrigation time reaching to the completely emitter clogging percent (h),

L: Lateral line length (m),

S: Emitter spacing (m),

d: Lateral line diameter (m) and

W: Suspended material wight ($kg\ m/h^2$).

P_{clog} : Emitter clogging percent, %.

The calculated programmer method

The QB64 inputs was the laboratory values of the affected parameters which were (q, E_c, w, T, L, S, d and p_{clog} %).

The data was entered to the program as DAT data (*.dat) by Grapher10 program and set the equation type as exponential equation, then the output was the constant of the connected equation and the parameter's exponents. The following equation was concerned with the relationship between clogging percent and the other parameters.

$$P_{clog}\% = 2.75 \frac{EC^{2.01} L^{2.37} t^{0.11}}{q^{2.02} S^{2.04} d^{0.75} W^{0.87}} \qquad (7)$$

To prove the strength of theoretical and calculated emitter clogging percent relationship whether it's positive or negative correlation as shown in the next curves Figs. 5 and 6. The field emitter clogging percent data was compared with theoretical data from the QB64 program to verify of the theoretical results. Results showed that the calculated values of the emitter clogging percent from the estimated equation were compatible with the actual values as shown in Fig. 5 and Fig.6.

Table (6): Operation time per hour according to water, filtration process and emitter type.

Filters Type	Emitters Type	Nile Water	Treated Drainage Water	Drainage Water
Sand Filter	Long path emitter	880	740	640
	PC emitter	620	580	540
	Short path emitter	560	480	380
Sand and Screen Filter	Long path emitter	1780	1340	1100
	PC emitter	960	820	740
	Short path emitter	940	780	660

Source: Experimental data.

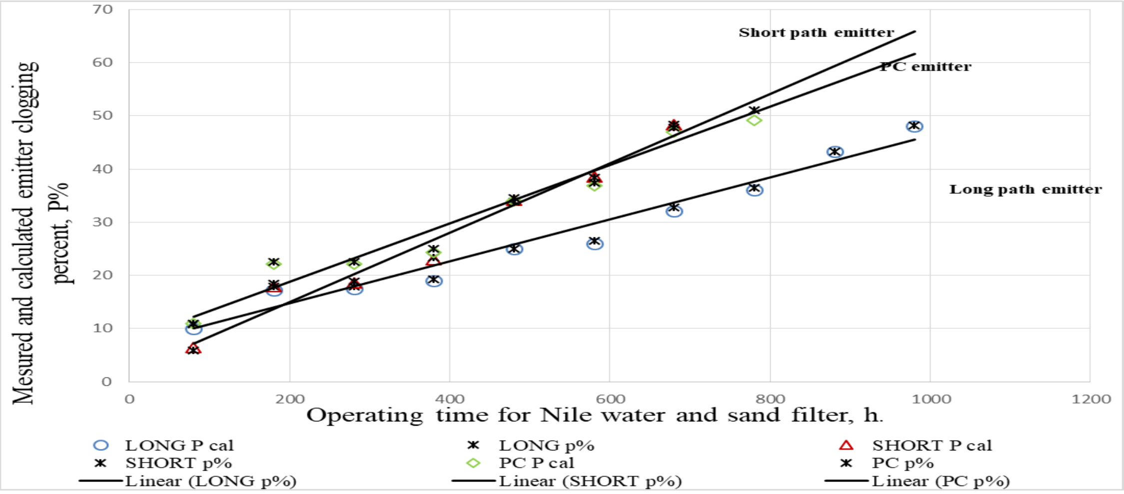

Fig (5.a): The emitter clogging percent theoretical and calculated relationship for Nile water and first filtration process.

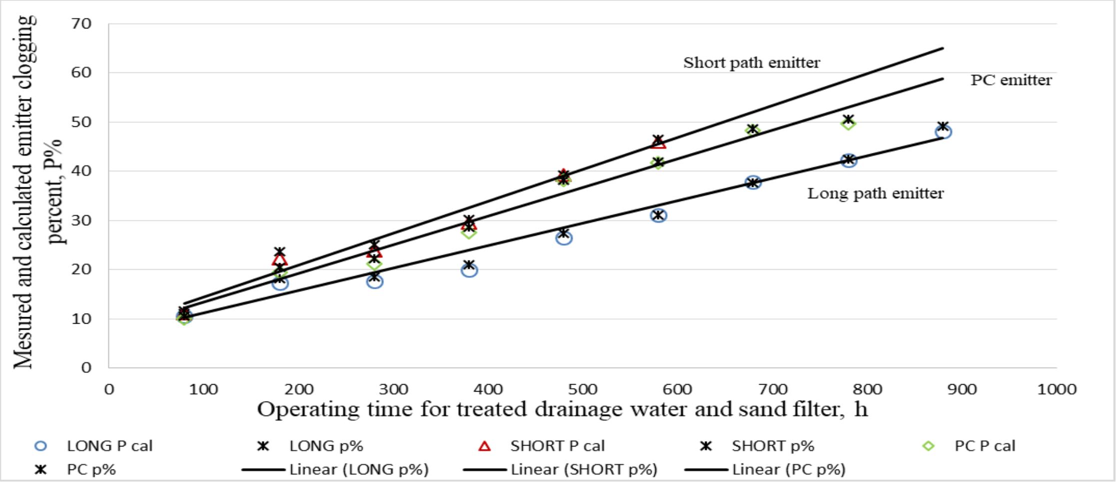

Fig (5.b): The emitter clogging percent theoretical and calculated relationship for treated drainage water and first filtration process.

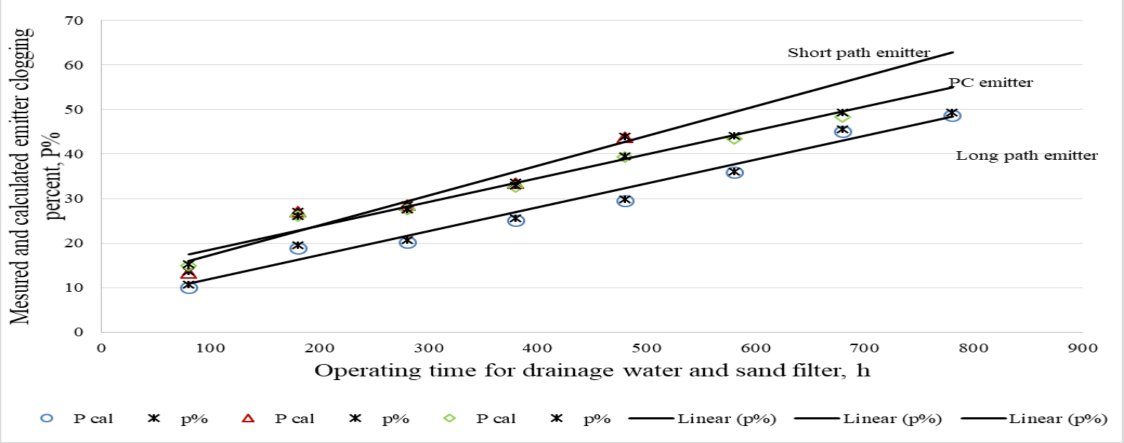

Fig (5.c): The emitter clogging percent theoretical and calculated relationship for drainage water and first filtration process.

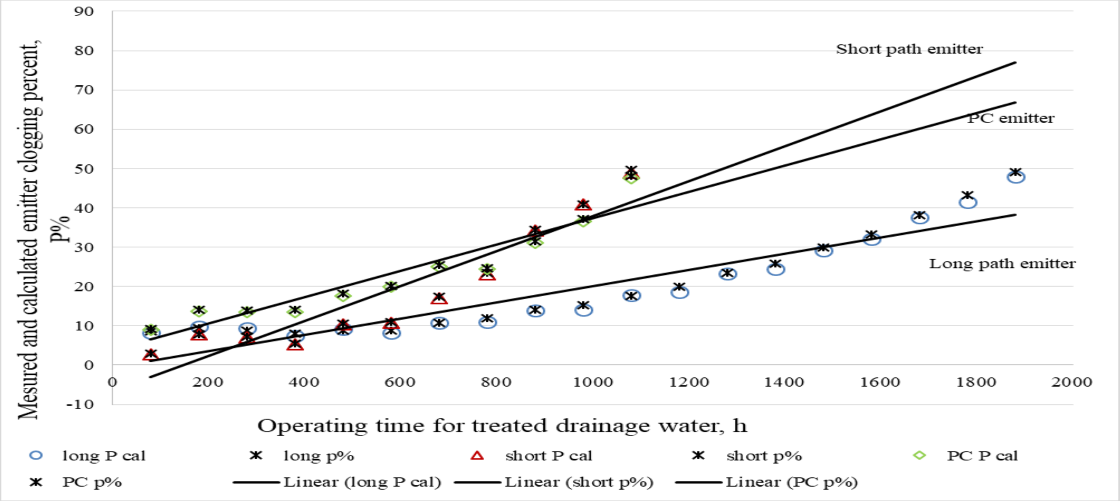

Fig (6.a): The emitter clogging percent theoretical and calculated relationship for Nile water and second filtration process.

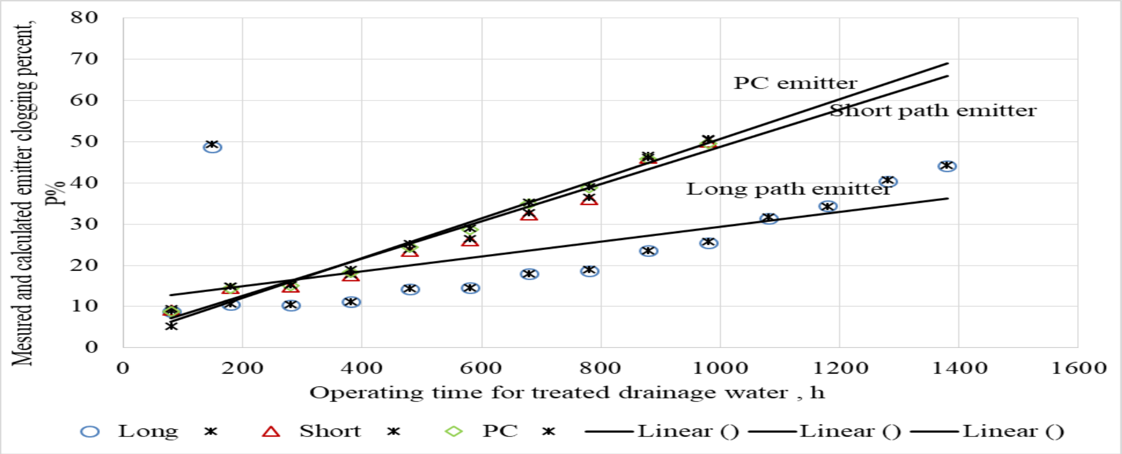

Fig (6.b): The emitter clogging percent theoretical and calculated relationship for treated drainage water and second filtration process.

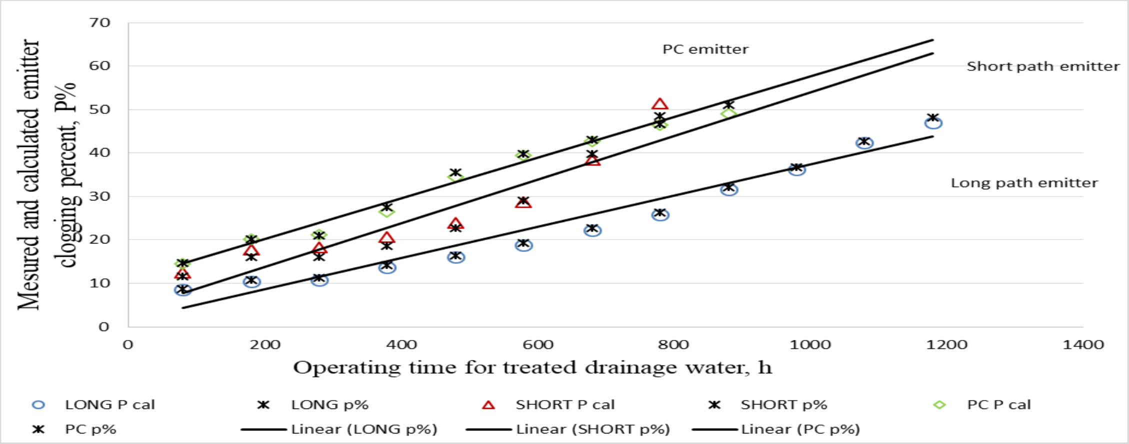

Fig (6.c): The emitter clogging percent theoretical and calculated relationship for drainage water and second filtration process.

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تأثير جودة مياه الرى المختلفة على نسبة انسداد النقاطات

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الملخص العربي

أجريت هذه الدراسة بمعمل الري بقسم الهندسة الزراعية والنظم الحيوية بكليه الزراعة– جامعة المنوفية بمدينه شبين الكوم خلال عامى 2018& 2019 واستهدفت قياس مدى تأثير جودة مياه الرى على إنسداد النقاطات الأكثر إستخداماً في جمهورية مصر العربية وهى النقاطات طويلة المسار والنقاطات قصيرة المسار والنقاطات تعويضية الضغط، وذلك من خلال حساب قيمة نسبة الانسداد خلال فترات التشغيل وصولا الى نسبة الانسداد الكلى، وأيضاً دراسة تأثير استخدام عملية تنقية مياه الرى المستخدمة على نسبة الانسداد و الأداء الحقلى لنظام الرى بالتنقيط من خلال نظامين للتنقية هما الاولى الفلتر الرملى فقط، والثانية الفلتر الرملى والفلتر الشبكى معا.

ولتحقيق هذا الهدف تم عمل شبكة ري بالتنقيط روعي أن يكون بها إمكانية تغيير العوامل المؤثرة مثل درجة جوده المياه ونوع النقاط المستخدم ونظام التنقية، بالاضافة الى رؤية دراسة تأثير تغير عوامل الدراسة على إنسداد النقاطات بأنواعها. واحتوى نظام الرى بالتنقيط على خزان مصنوع من البلاستيك بحجم 1 م^3 كمصدر لمياه الرى وخط رى رئيسي بقطر 38 مم وبطول 1 متر وتم استخدام مضخه طارده مركزية ذات قدرة 0.75 كيلو وات، وخط رى تحت رئيسي بطول 6 متر وقطر 25,4 مم ملحق بمنظم ضغط وعداد لقياس ضغط التشغيل وتم تركيب خطوط الري الفرعية على مسافات 75 سم فيما بينها وبطول 45 متر وبقطر داخلي 16 مم وبمسافة 50 سم بين النقاطات وإستخدمت النقاطات موضوع الدراسة بتصرف 4 لتر/ساعة لكل نوع .

وأجريت الدراسة على عدد 90 نقاط لكل مستوى من مستويات جوده مياه الرى المختلفة وهى (مياه النيل، ومياه الصرف الزراعي، ومياه الصرف الزراعى المعالج بنسبة 1:1) للتنقية بواسطة الفلتر الرملى فقط،والتنقية بالفلتر الرملى و الفلتر الشبكى معا. وصممت التجربة احصائيا بالقطاعات المنشقة العشوائية (split split plot design) وتم تحليل النتائج بإستخدام برنامج SPSS وتم ترتيبها بإختبار دانكن.

واستخدمت نظرية باكنجهام (BUCKINGHAM (Pi) THEOREM) وايضا البرنامج الحسابى BQ64، لاستنباط صيغة رياضية تعبر عن معادلة انسداد النقاطات وتم مقارنتها مع النتائج المعملية.

وتوصلت الدراسة إلى النتائج الآتية

1. حقق النقاط طويل المسار أقصى عدد لساعات التشغيل مثل حدوث الانسداد الكامل حيث كانت 800، 780 & 680 عند استخدام مياه النيل، ومياه الصرف الزراعى المعالج، ومياه الصرف الزراعى على الترتيب فى حالة استخدام الفلتر الرملى فقط كنظام للتنقية.
2. تحقق أقل عدد لساعات التشغيل للنقاط قصير المسار حيث كانت 582، 480& 380 عند استخدام مياه النيل، ومياه الصرف الزراعى المعالج، و مياه الصرف الزراعى على الترتيب فى حالة استخدام الفلتر الرملى فقط كنظام للتنقية.
3. تحقق أقصى عدد لساعات التشغيل عند استخدام نظام التنقية بالفلتر الرملى، والفلتر الشبكى معا عند النقاط طويل المسار حيث كانت 1780، 1380 & 1180 ساعة عند مياه النيل، ومياه الصرف الزراعى المعالج، و مياه الصرف الزراعى على الترتيب.

4. تحقق أقل عدد لساعات التشغيل قبل حدوث الانسداد الكامل عند استخدام النقاط قصير المسار مع مياه النيل، ومياه الصرف الزراعى المعالج، و مياه الصرف الزراعى على الترتيب عند استخدام الفلتر الرملى والفلتر الشبكى كنظام للتنقية.
5. تحققت أقل قيمة متوسطة لنسبة انسداد النقاط طويل المسار ومقدارها 47.6%، 48.6% & 50.3% عند مياه النيل، ومياه الصرف الزراعى المعالج، و مياه الصرف الزراعى على الترتيب.
6. تحقق أقل معدل تغير فى تصرف النقاط وقيمته (20 ، 22& 27%) عند استخدام النقاط طويل المسار مقارنة بالنقاط قصير المسار (32، 35 & 40%) والنقاط معوض الضغط(28، 31& 27%).
7. تطابقت معادلة نسبة الانسداد للنقاطات $\left[P_{clog} = 100\left(1 - \frac{q_n}{q_c}\right)\right]$ ، والمشتقة عمليا مع كل من المعادلة المستنبطة بنظرية باكنجهام BUKINGHAM Pi THEOREM وبرنامج QB64 .
8. أظهرت نتائج التحليل الاحصائى وجود فروق معنوية لكل من مستوى جوده مياه الرى المستخدمة ونظام التنقية.