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Investigation and Evaluation of Perforated Pipes System Using Plastic Microfilm for Improving Surface Irrigation Performance

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ABSTRACT

Irrigation using the perforated pipes system is a way for furrow and border irrigation, and it has been perhaps one of the simplest and most effective ways of improving the flexibility and efficiency of water supplies. The main objective of this work is to study the possibility of utilizing plastic microfilm as a perforated tube for irrigation. Also, studying some factors that affect water uniformity distribution along perforated plastic microfilm tubes (PPMT). Plastic microfilm tubes with different diameters of 190, 254, and 320 mm were investigated to use as perforated tubes for irrigation with orifices diameters of 20, 40, 60, and 80 mm. The obtained results of the tube diameter of 190 mm generally showed that the pressure head dropped gradually in the perforated plastic microfilm tube and this dropping trend ended after that increased gradually until the tube ended. The pressure head variation (H_{var}) along the tube was about 31.25% and 25.81 % for orifices diameters of 20, and 40 mm, respectively. The actual discharge (Q_{act}) of the orifices were closely varied along the tube length. Meanwhile, the theoretical discharge (Q_{th}) dropped gradually in the tube. The discharge variation (Q_{var}) along the tube was about 40.49% and 12.06% for orifices diameters of 20, and 40 mm, respectively. The pressure head variation value ranged from 25.81 to 64.71% and the discharge variation ranged from 12.06 to 58.66% for investigation conditions.

***Keywords*:** Surface Irrigation; Gated Pipes; Perforated Pipes; Plastic Microfilm.

INTRODUCTION

Irrigation using the perforated pipes system is a way for furrow and border irrigation and it has been perhaps one of the simplest and most effective ways of improving the flexibility and efficiency of water supplies. Many significant benefits come with surface irrigation. A local irrigation system is typically at least somewhat familiar with how to run and maintain the system because it is one of the most commonly used. The fact that surface irrigation systems are less influenced by climatic and water quality factors is another advantage. The perforated pipe system is a simplified type of gated pipes system. Gated pipe irrigation is a type of furrow irrigation in which the conventional head ditch and siphons are replaced by an above-ground pipeline. Orifices spaced regularly along the pipeline allow irrigation water to flow out. Divided manifold flow is demonstrated by a gated pipeline. Like in any case of manifold flow, the flow in the pipeline is spatially variable, steady, and decreases to almost zero at the closed end of the pipeline (Smith et al., 1986). Morcos et al. (1994), using perforated tubes as a way to increase the effectiveness of surface irrigation techniques (borders and furrows). The perforated pipe is primarily made of a field-manageable, portable line. The pipeline is typically made of aluminum or PVC and has evenly spaced outlets. An automatic surface irrigation system with gated pipe, according to Krinner et al. (1994), can be a very effective way to apply irrigation, with a water application efficiency of 91%. In using a gated pipe system for furrow irrigation, Omara (1997) found increase each the irrigation application efficiency and irrigation distribution efficiency to 72.5% and 92 %, respectively. Surface irrigation methods were developed using a perforated pipe system and exact land leveling on a sugarcane area in the old valley in Egypt (El-Tantawy et al., 2000). The perforated pipes system increases agricultural production by increasing yield per unit area and by saving water so that more land can be irrigated. Also, according to El-Yazal et al. (2002), perforated pipes are preferable for improving surface irrigation on old lands, particularly in maize crops under discharge 1.5 l/s for orifice per furrow with slope 0.1%. The perforated pipe system increases yield per unit area and saves water, allowing for the irrigation of a larger area, both of which have a positive impact on agricultural production. The application efficiencies ranged widely, with a mean of 48% and a range of 17% to 100% and were generally much less than desirable (Smith et al., 2005). Applying simple, inexpensive irrigation management techniques that involve increased furrow flow rates and shorter irrigation times can significantly increase application efficiencies and decrease deep drainage losses. The factors affecting the effectiveness of water irrigation, according to Omara (1997), include the irrigation method, soil type, water irrigation depth, furrow width, soil texture, land preparation, and infiltration rate variability. Otherwise, Hassan (1998) recommended the length, discharge rate, internal diameter, and pipe slope of the perforated pipe are the variables that affect the distribution of water uniformity along the pipe. According to El-Awady et al. (2002), Amer et al. (2017), and Gomaa et al. (2019), the water uniformity distributions along the gated pipe (18 m) were approximately 96% using the following parameters: gate spacing 0.75 m., pipe diameter 0.15 m, gate discharge 1.5 L/s, and initial head 0.5 m. The water infiltrated depth along the furrow and the uniformity in surface irrigation systems are both influenced by a variety of engineering factors. These variables include inlet flow, soil type, furrow slope, length, shape, and cultivated crop, all of which are design parameters that influence

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water infiltration, advance, depletion, storage, and recession. Therefore, the distribution of infiltrated water is the result of all the functions or phases that came before. Osman et al. (2005) stated that using gated pipes irrigation system results in water saving by (29.64%, 29.9%, 14.5%, and 19.7%) for cotton, wheat, corn and rice respectively compared with traditional surface irrigation system. Economic studies revealed that the trailing perforated pipe irrigation system was less expensive than the gated pipe irrigation system. For wheat and maize, Abousrie et al. (2019) found that using gated pipe irrigation system increased the values of yield by 24.4 % and 16.3 % respectively, the water use efficiency by 26.5 % and 16.7% respectively compare with traditional surface irrigation system. The trailing perforated pipe irrigation system reduces soil erosion under the outlets along with the system, directs irrigation water exit from the opening towards the irrigation furrows, and can be used to water any types of crops planted through any furrow spacing (Abdel-hady, 2018). Sayed et al. (2022) found that the trailing perforated pipe irrigation system is better than the gated pipe for improving irrigation efficiency and crop productivity. Where, distribution efficiency of water was 97.2% for trailing perforated pipe and 95.8% for gated pipe and water use efficiency increased using trailing perforated pipe than the gated pipe irrigation system. Irrigation using the perforated pipes system is a type of furrow and border irrigation and either rigid or lay flat has been perhaps one of the simplest and most effective ways of improving the flexibility and efficiency of canal water supplies.

The main objective of this work is to study the possibility of utilizing plastic microfilm as a perforated tube for irrigation. Also, studying some factors that affect water uniformity distribution along perforated plastic microfilm tubes.

MATERIALS AND METHODS

The present work was carried out at Shebin El-Kom area. In order to choose the appropriate parameters for the perforated pipes such as different tube diameter, orifices diameter, optimum pressure head and discharge, an experiment has been carried out. Plastic microfilm 200 micron tubes with different diameters of 190, 254, and 320 mm were investigated to use as perforated tubes for irrigation with orifices diameters of 20, 40, 60, and 80 mm. The current investigation evaluates developed surface irrigation systems and their effects on system efficiency using locally produced perforated plastic microfilm.

Perforated tube system

The pumping unit was attached to the perforated plastic microfilm via their couples and the control unit. Fig. 1 and Table (1) display the specifications of the perforated plastic microfilm.

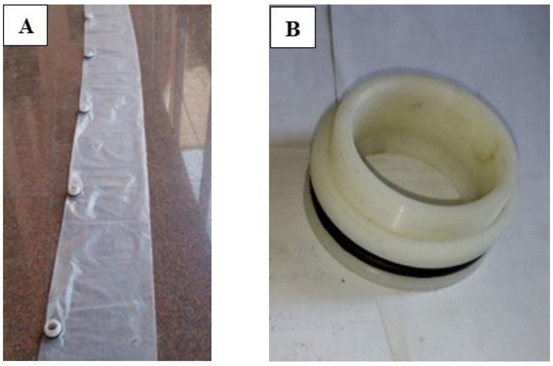


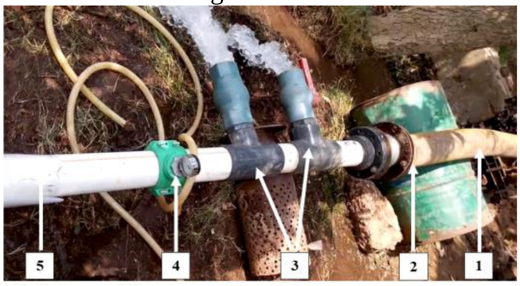
Fig. 1. (A) the perforated plastic microfilm and (B) orifices material

Table 1. The specifications of the perforated plastic microfilm material

Type	Length, m	diameter, mm	Thickness, microns	Max. operating head, bar
Plastic microfilm	Open	Varied	200 microns	0.6

Evaluation of perforated plastic microfilm

The used tube for the evaluation test was 10 m in length and along this length, it used bends, a spigot, and a faucet rubber ring for joining the system as shown in Fig. 2. The measurements of both orifice flow rate and water head were done as shown in Figs. 3.



(1) From pump delivery
(2) Flange 6 inch
(3) Two valve 6 inch connected by T 6 inch
(4) Pressure gauge
(5) To Perforated Tube

Fig. 2. Control unit of the used perforated plastic microfilm irrigation system

Fig. 3. Measurements of orifices water head and flow rate

Pumping unit and its components

The pumping unit (Fig. 4) consists of a centrifugal pump that is driven by a diesel engine under various conditions. Suction pipes that end in non-return valves connect the pumps. Through a ditch used for treatment, water was supplied. The Perforated Plastic Microfilm was attached to the discharge side of every pumping unit. A flow meter, discharge valve, and pressure gauge were all included on each pumping unit's discharge side in order to measure the flow head at the pumping head. The specifications of the pumping unit (pump and engine) are shown in Table (2).

Fig. 4. Engine and pumping unit

Table 2. The pump unit specification for the irrigation system

Type of pump	Pump made	Engine speed (rpm)	Engine power (hp)	Max. discharge (m^3/h)	Max. operating pressure (Bar)	Suction pipe Diameter (Inch)	Delivery pipe Diameter (Inch)
Centrifugal	Diesel Shobra	1460	7.8	130	1	6	6

Flow rate and pressure head measuring

Measurements of water flow from each orifice were taken in order to determine the outflow characteristics of the orifices.

The variation of flow through perforated pipes system (Q_{var}) can be determined using the following equation:

$$Q_{var} = \frac{Q_{max} - Q_{min}}{Q_{max}} \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where Q_{max} is the maximum outlet flow along the lateral line, and Q_{min} is the minimum outlet flow along the lateral line.

The pressure head variation through perforated tubes system (H_{var}) can be determined using the following equation:

$$H_{var} = \frac{H_{max} - H_{min}}{H_{max}} \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where H_{max} is the maximum pressure in lateral line by m, and H_{min} is the minimum pressure in lateral line (m).

The coefficient of discharge could be found out by collecting the water flowing from the orifice in a tank of known capacity and also measuring out the head causing flow, which is kept constant through the experiment. Then coefficient of discharge (C_d) can be found out according to Sarao and Khosla, (1980) using the Eq. (3).

$$C_d = \frac{Actual\ discharge}{Theoritical\ discharge} \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

According to Douglass et al., (1981), the discrepancy between the theoretical and actual discharge due to the loss of energy between the velocity at the free surface and the velocity of the orifices, which causes the velocity of the orifices to be less than that predicted by Torricelli's equation (4).

$$Q = A_0 \times V_{th} = A_0 \times \sqrt{2\ g\ h} \;\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where Q is theoretical discharge (m^3/s), A_o is the cross section area of the orifice (m^2), V_{th} is the theoretical velocity (m/s), g is the acceleration of gravity (m/s^2), and h is the pressure head (m).

RESULTS AND DISCUSSION

Evaluation of the microfilm tube diameter of 190 mm results

The determined and measured discharges (m^3/h) for the outlets of the perforated plastic microfilm tube (PPMT) are presented in Figures 5 and 6 for the tube diameter of 190 mm and orifice diameter of 20 mm. The results data showed that the range of pressure head was from 0.22 m to 0.32 m. The pressure head dropped gradually in the perforated plastic microfilm tube and this dropping trend ended. After that, the measured pressure head increased gradually until it reached the perforated plastic microfilm tube end. The relationship between the pressure head and the perforated plastic microfilm length decreased to 73 % of the tube length and after that increased to the end of the tube end. The increasing of the pressure head at the tube line end due to the back pressure at the tube line's end. The pressure head was 0.32 m at the beginning of the tube and decreased to 0.22 cm at 73 % of the tube length. After that, the pressure head increased till the end of tube line. The pressure head variation ranged between zero cm at the beginning of the perforated plastic microfilm tube and 0.05 m at the end of the perforated plastic microfilm tube (Fig. 5). The variation between the maximum pressure head and the minimum pressure head (H_{var}) along perforated plastic microfilm was about 31.25%. Under field experiment conditions, the perforated tube system's pressure head and discharge rate exhibited a decreasing relationship. At the tube line's end, the discharge rate increased after the pressure head in the perforated tube gradually decreased.

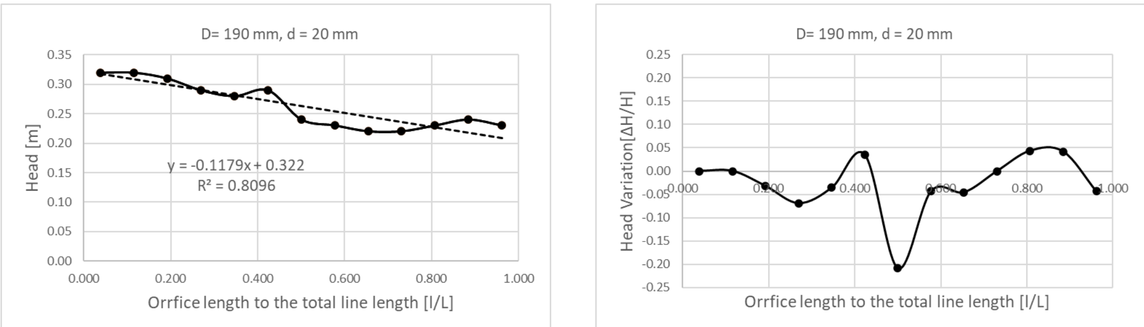
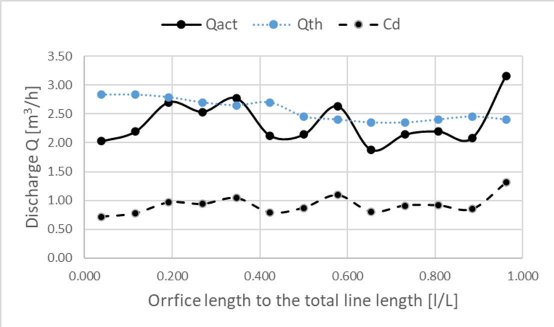


Fig. 5. (A) The relationship between the orifice head (m) and (B) the head variation along the orifice length (l/L) for the tube diameter of 190 mm and the orifice diameter of 20 mm

The results of orifices actual discharge (Q_{act}) were nearly varied along the length of the perforated plastic microfilm tube from 1.879 to 3.158 m^3h. The actual discharge variation ranged between zero m^3h at the beginning of the perforated plastic microfilm tube and 1.07 m^3h at the end of the perforated plastic microfilm tube. Meanwhile, the theoretical discharge of orifices (Q_{th}) dropped gradually in the perforated plastic microfilm tube and this dropping trend ended. After that, the theoretical discharge of orifices (Q_{th}) increased gradually until it reached the end of perforated plastic microfilm tube. The results of theoretical discharge of orifices decreased to 73 % of the tube length and after that increased to the end of the perforated plastic microfilm tube. The perforated plastic microfilm discharge dropped, due to friction head losses then there was a gradual increase in it due to the increase in pressure head which counteracted the effect of friction head losses. Similar results were reported by El-Awady et al. (2009). The reported results confirmed in general that, the outflow discharge of the perforated tube along each orifice is nonuniform; in other words, the variation in the flow velocity and flow rate in the perforated tube along the tube length is a function of the orifice location along the tube. Due to the uniform section of the tube, the tube diameter remains constant along the tube line, and the tube velocity is proportional to the flow rate. Similar results were reported by Qin et al. (2017). The discharge variation value (Q_{var}) along perforated plastic microfilm was about 40.49%. The discharge coefficient decreased as the pressure head of orifice and of superimposed head increased. The values from the tested orifices ranged between 0.71 to 1.31. The discharge coefficient ranged between 0.71 for the orifices at the beginning of perforated plastic microfilm tube, then tended to increase to 1.31 at the end of perforated plastic microfilm tube (Fig. 6). Similar results were reported by El-Awady et al. (2009).



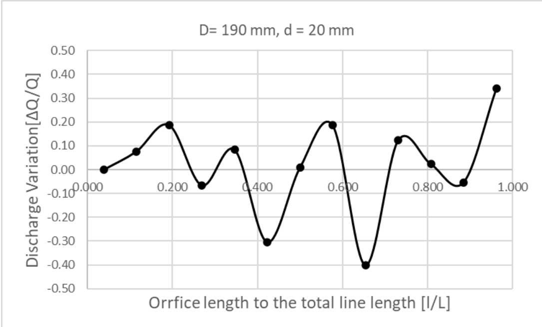
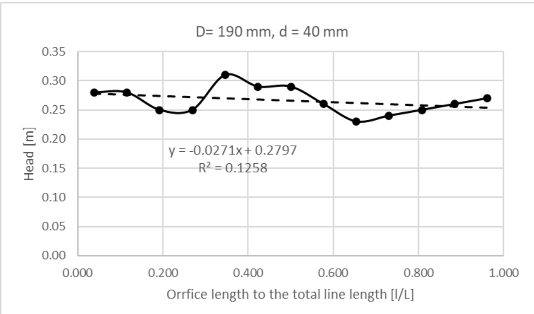


Fig. 6. (A) The relationship between the orifice discharge (m^3/h) and (B) the discharge variation along the orifice length for the tube diameter of 190 mm and the orifice diameter of 20 mm

The determined and measured discharges (m^3/h) for the outlets of the perforated plastic microfilm tube are presented in Figures 7 and 8 for the tube diameter of 190 mm and orifice diameter of 40 mm. The reported results data showed that the pressure head ranged from 0.23 m to 0.31 m. The pressure head dropped gradually in the perforated plastic microfilm tube and this dropping trend ended. After that, the measured pressure head increased gradually until it reached the end of perforated plastic microfilm tube. The relationship between the pressure head and the perforated plastic microfilm length decreased to 65 % of the tube length and after that increased to the end of the tube. The pressure head was 0.31 m at the beginning of the tube and decreased to 0.21 cm at 65 % of the tube length. After that, the pressure head increased till the end of tube and reached 0.27 m. As mentioned before, the increasing of the pressure head at the tube line end due to the back pressure at the tube line's end. The pressure head variation ranged between zero m at the beginning of the perforated plastic microfilm tube and 0.06 m at the end of the perforated plastic microfilm tube (Fig. 7). The variation between the maximum pressure head and the minimum pressure head along perforated plastic microfilm was about 25.81%. Therefore, the discharge regulation outlet the orifices along perforated plastic microfilm was about 25.81%. Therefore, the pressure head regulation outlet the orifices along perforated plastic microfilm was about 31.25%. Under field experiment conditions, the perforated tube system's pressure head and discharge rate exhibited a decreasing relationship. At the tube line's end, the discharge rate increased after the pressure head in the perforated tube gradually decreased.



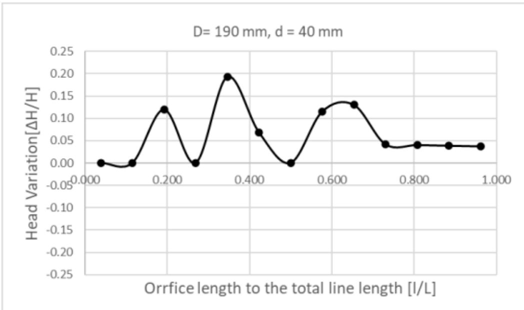


Fig. 7. (A) The relationship between the orifice head (m) and (B) the head variation along the orifice length (l/L) for the tube diameter of 190 mm and the orifice diameter of 40 mm

The results of orifices actual discharge (Q_{act}) were nearly varied along the length of the perforated plastic microfilm tube from 8.856 to 10.152 m^3/h. The actual discharge variation ranged between zero m^3/h at the beginning of the perforated plastic microfilm tube and 1.11 m^3/h at the end of the perforated plastic microfilm tube. Meanwhile, the theoretical discharge of orifices (Q_{th}) dropped gradually in the perforated plastic microfilm tube and this dropping trend ended. After that, the theoretical discharge of orifices (Q_{th}) increased gradually until it reached the end of perforated plastic microfilm tube. The results of theoretical discharge of orifices decreased to 65 % of the tube length and after that increased to the end of the perforated plastic microfilm tube. The perforated plastic microfilm discharge dropped, due to friction head losses then there was a gradual increase in it due to the increase in pressure head which counteracted the effect of friction head losses. Similar results were reported with small orifices of 20 mm and also by El-Awady et al. (2009). The reported results confirmed in general that, the outflow discharge of the perforated tube along each orifice is nonuniform; in other words, the variation in the flow velocity and flow rate in the perforated tube along the tube length is a function of the orifice location along the tube. Due to the uniform section of the tube, the tube diameter remains constant along the tube line, and the tube velocity is proportional to the flow rate. Similar results were reported by Qin et al. (2017). The discharge regulation outlet the orifices along perforated plastic microfilm was about 12.06%. The discharge coefficient decreased as the pressure head of orifice and of superimposed head increased. The calculated values from the tested orifices ranged between 0.88 to 0.98. The discharge coefficient ranged between 0.88 for the orifices in the middle of the perforated plastic microfilm tube, then tended to increase to 0.98 at the end of the perforated plastic microfilm tube (Fig. 8). The results of this orifice diameter are in agreement with the results found with the orifices diameter of 20 mm and also by El-Awady et al. (2009).

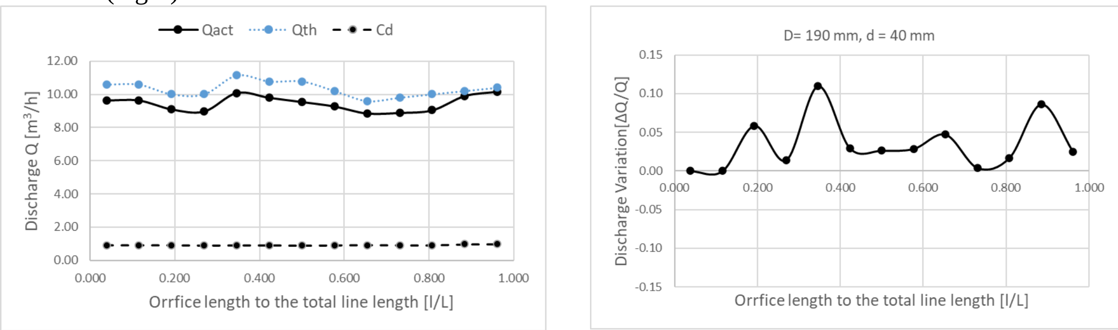


Fig. 8. (A) The relationship between the orifice discharge (m^3/h) and (B) the discharge variation along the orifice length for the tube diameter of 190 mm and the orifice diameter of 40 mm

1. Evaluation of the microfilm tube diameter of 254 mm results

The determined and measured discharges (m^3/h) for the outlets of the perforated plastic microfilm tube are presented in Figures 9 and 10 for the tube diameter of 254 mm and orifice diameter of 60 mm. The results data showed that the pressure head ranged from 0.06 m to 0.17 m. The pressure head increased gradually in the perforated plastic microfilm tube until it reached the end of perforated plastic microfilm tube. The pressure head was 0.06 m at the beginning of the tube and increased till the end of tube and reached 0.17 m. The pressure head variation ranged between zero m at the beginning of the perforated plastic microfilm tube and 0.03 m at 26 % of the tube length of the perforated plastic microfilm tube (Fig. 9). The variation between the maximum pressure head and the minimum pressure head along perforated plastic microfilm was about 64.71%.

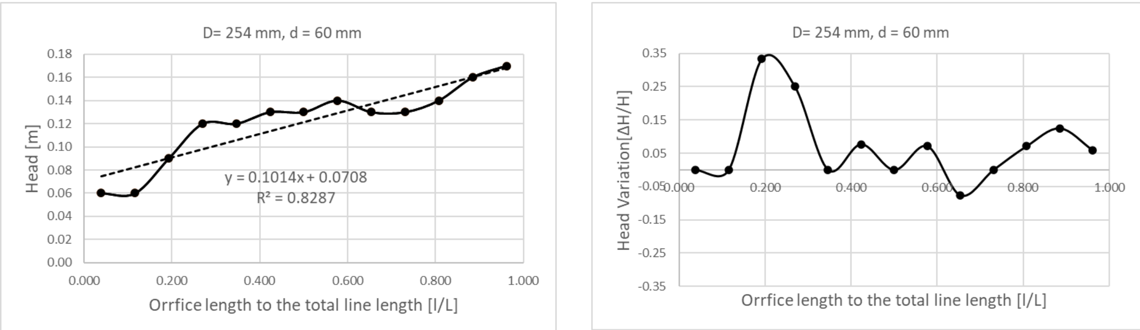


Fig. 9. (A) The relationship between the orifice head (m) and (B) the head variation along the orifice length (l/L) for the tube diameter of 254 mm and the orifice diameter of 60 mm

The results of orifices actual discharge (Q_{act}) were nearly varied along the length of the perforated plastic microfilm tube from 8.172 to 11.664 m^3/h. The actual discharge variation ranged between zero m^3/h at the beginning of the perforated plastic microfilm tube and 3.465 m^3/h at 19 % of the tube length of the perforated plastic microfilm tube (Fig. 10). Meanwhile, the theoretical discharge of orifices (Q_{th}) increased gradually in the perforated plastic microfilm tube until it reached the end of perforated plastic microfilm tube. The reported results of this tube and orifice diameter are not in agreement with the results were reported with tube diameter of 190 mm and orifices diameters of 20 and 40 mm and also by El-Awady et al. (2009). The reported results confirmed in general that, the outflow discharge of the perforated tube along each orifice is nonuniform; in other words, the variation in the flow velocity and flow rate in the perforated tube along the tube length is a function of the orifice location along the tube. Due to the uniform section of the tube, the tube diameter remains constant along the tube line, and the tube velocity is proportional to the flow rate. Similar results were reported by Qin et al. (2017). The discharge variation (Q_{var}) along perforated plastic microfilm (Table 3) was about 41.67%. The discharge coefficient decreased as the pressure head of orifice and of superimposed head increased. The values from the tested orifices ranged between 0.44 to 1.06. The coefficient of discharge ranged between 1.06 for the orifices at the beginning of perforated plastic microfilm tube, then tended to decrease till 0.44 at 26 % of the tube length of the perforated plastic microfilm tube (Fig. 10). These results are in agreement with the results were reported with tube diameter of 190 mm and orifices diameters of 20 and 40 mm and also by El-Awady et al. (2009).

2. Evaluation of the microfilm tube diameter of 320 mm results

The determined and measured discharges (m^3/h) for the outlets of the perforated plastic microfilm tube are presented in Figures 11 and 12 for the tube diameter of 320 mm and orifice diameter of 60 mm. The results data showed that the pressure head ranged from 0.09 m to 0.13 m. The pressure head increased gradually in the perforated plastic microfilm tube until it reached 45 % of the tube length, after that the pressure head decreased gradually until it reached the end of perforated plastic microfilm tube. The pressure head was 0.09 m at the beginning and end of the tube and increased till 45 % of the tube length and reached 0.13 m. The pressure head variation ranged between zero m at the beginning and the end of the perforated plastic microfilm tube and 0.05 m at 37 % of the tube length of the perforated plastic microfilm tube (Fig. 11). The discharge regulation outlet the orifices along perforated plastic microfilm was about 38.46%.

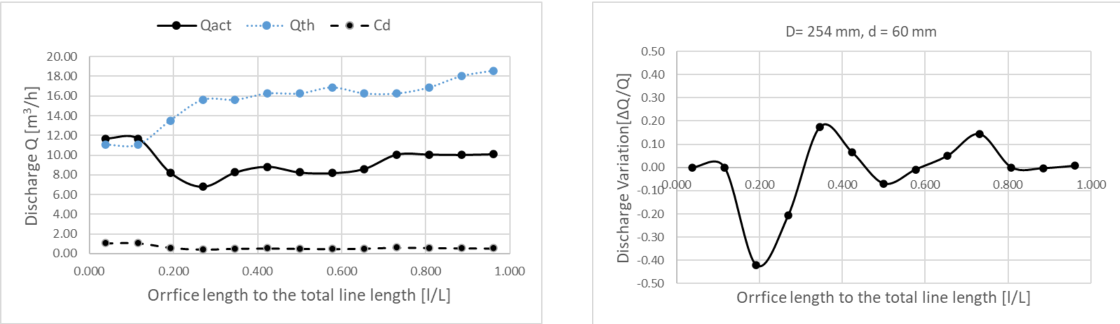


Fig. 10. (A) The relationship between the orifice discharge (m^3/h) and (B) the discharge variation along the orifice length for the tube diameter of 254 mm and the orifice diameter of 60 mm

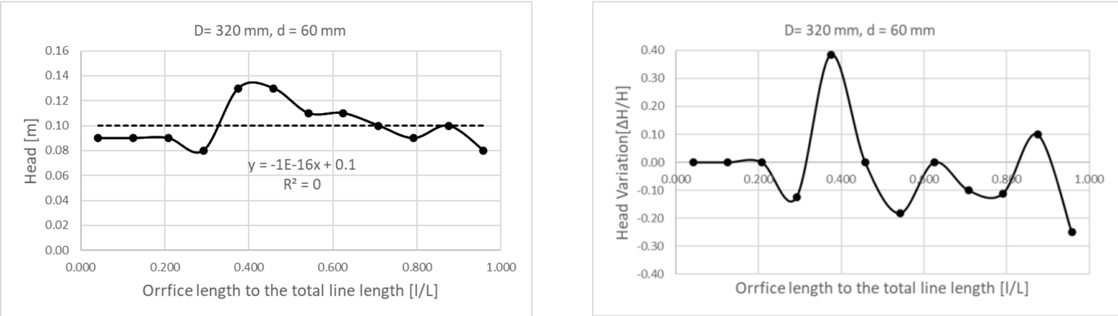


Fig. 11. (A) The relationship between the orifice head (m) and (B) the head variation along the orifice length (l/L) for the tube diameter of 320 mm and the orifice diameter of 60 mm

The results of orifices actual discharge (Q_{act}) were nearly varied along the length of the perforated plastic microfilm tube from 7.272 to 13.212 m^3h. The actual discharge variation ranged between zero m^3h at the beginning of the perforated plastic microfilm tube and 4.03 m^3h at 45 % of the tube length of the perforated plastic microfilm tube (Fig. 12). Meanwhile, the theoretical discharge of orifices (Q_{th}) increased gradually in the perforated plastic microfilm tube until it reached 45 % of the tube length, after that the theoretical discharge decreased gradually until it reached the end of perforated plastic microfilm tube. The reported results of this tube and orifice diameter are not in agreement with the results were reported with tube diameter of 190 mm and orifices diameters of 20 and 40 mm and also by El-Awady et al. (2009). The reported results confirmed in general that, the outflow discharge of the perforated tube along each orifice is nonuniform; in other words, the variation in the flow velocity and flow rate in the perforated tube along the tube length is a function of the orifice location along the tube. Similar results were reported by Qin et al. (2017). The discharge regulation outlet the orifices along perforated plastic microfilm was about 44.96%. The discharge coefficient decreased as the pressure head of orifice and of superimposed head increased. The values from the tested orifices ranged between 0.51 to 0.85. The discharge coefficient ranged between 0.85 for the orifices at 54% of the tube length of the perforated plastic microfilm tube, then tended to decrease to 0.51 at 70 % of the tube length of the perforated plastic microfilm tube (Fig. 12). These results are in agreement with the results were reported with tube diameter of 190 mm and orifices diameters of 20 and 40 mm and also by El-Awady et al. (2009).

The determined and measured discharges (m^3/h) for the outlets of the perforated plastic microfilm line are presented in Figures 13 and 14 for the tube diameter of 320 mm and orifice diameter of 80 mm. The reported results clarified that the pressure head ranged from 0.06 m to 0.12 m. The pressure head decreased gradually in the perforated plastic microfilm tube until it reached the end of perforated plastic microfilm tube. The pressure head was 0.12 m at the beginning of the tube and decreased till the end of tube and reached 0.06 m. The pressure head variation ranged between zero m at the beginning of the perforated plastic microfilm tube and 0.05 m at the end of the perforated plastic microfilm tube (Fig. 13). The pressure head variation (H_{var}) along perforated plastic microfilm tube reported in Table (3) was about 50.0%.

The results of orifices actual discharge (Q_{act}) were nearly varied along the length of the perforated plastic microfilm tube from 5.328 to 12.888 m^3h. The actual discharge variation ranged between zero m^3h at the beginning and end of the perforated plastic microfilm tube and 4.932 m^3h at 54 % of the tube length of the perforated plastic microfilm tube (Fig. 14). Meanwhile, the theoretical discharge of orifices (Q_{th}) decreased gradually in the perforated plastic microfilm tube until it reached the end of perforated plastic microfilm tube. The reported results of this tube and orifice diameter are not in agreement with the results were reported with tube diameter of 190 mm with orifices diameters of 20 and 40 mm, and also by El-Awady et al. (2009). The reported results confirmed in general that, the outflow discharge of the perforated tube along each orifice is nonuniform; in other words, the variation in the flow velocity and flow rate in the perforated tube along the tube length is a function of the orifice location along the tube. Similar results were reported by Qin et al. (2017). The discharge regulation outlet the orifices along perforated plastic microfilm was about 58.66%. The discharge coefficient decreased as the pressure head of orifice and of superimposed head increased. Rates from the tested orifices ranged between 0.25 to 0.57. The discharge coefficient ranged between 0.25 for the orifices at 87% of the tube length of the perforated plastic microfilm tube, then tended to increase to 0.57 at 45% of the tube length of the perforated plastic microfilm tube (Fig. 14). These results are in agreement with the results were reported with tube diameter of 190 mm and orifices diameters of 20 and 40 mm and also by El-Awady et al. (2009).

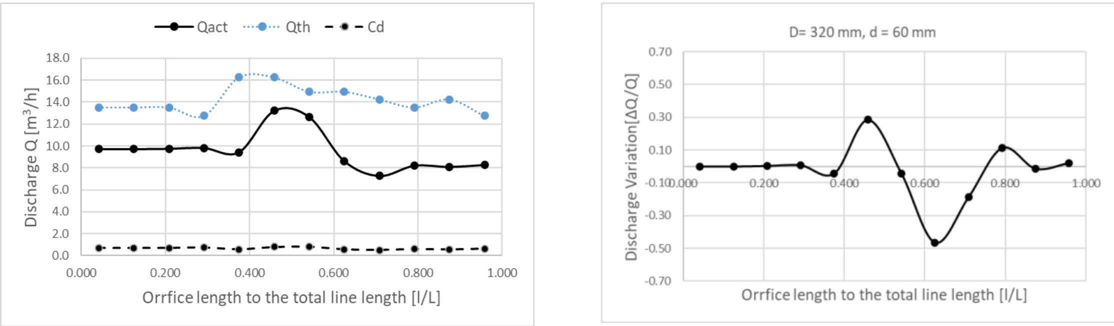


Fig. 12. (A) The relationship between the orifice discharge (m^3/h) and (B) the discharge variation along the orifice length for the tube diameter of 320 mm and the orifice diameter of 60 mm

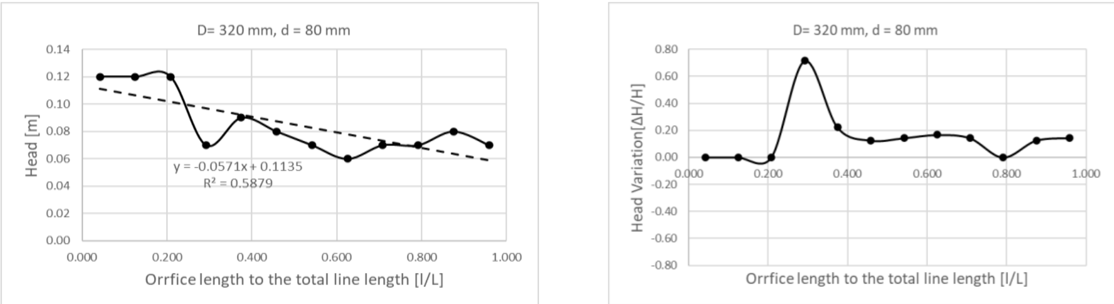


Fig. 13. (A) The relationship between the orifice head (m) and (B) the head variation along the orifice length (l/L) for the tube diameter of 320 mm and the orifice diameter of 80 mm

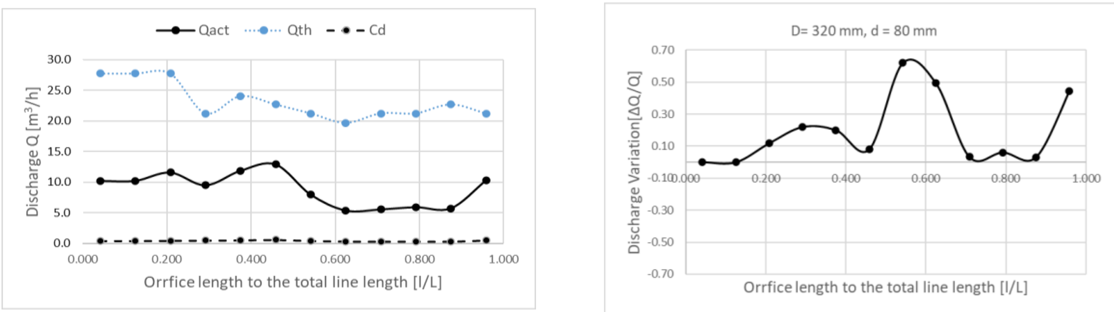


Fig. 14. (A) The relationship between the orifice discharge (m3/h) and (B) the discharge variation along the orifice length for the tube diameter of 320 mm and the orifice diameter of 80 mm

a. Results of pressure head and discharge variation

The pressure head variation (H_{var}) and discharge variation (Q_{var}) between the outlets of the perforated plastic microfilm orifices are presented in Tables (3) for the different tube diameter and orifice diameter. The reported results clarified that the variation between the maximum pressure head and the minimum pressure head (H_{var}) along perforated plastic microfilm ranged from 25.81 to 64.71%. Otherwise, the minimum value of the pressure head variation (H_{var}) reported for the perforated plastic microfilm diameter of 190 mm with orifice diameter of 40 mm. While the maximum value of the pressure head variation (H_{var}) was reported for the perforated plastic microfilm diameter of 254 mm with orifice diameter of 60 mm. Also, the reported results clarified that the discharge variation (Q_{var}) along perforated plastic microfilm ranged from 12.06 to 58.66%. Similarly, the minimum value of the discharge variation (Q_{var}) reported for the perforated plastic microfilm diameter of 190 mm with orifice diameter of 40 mm. But the maximum value of the discharge variation (Q_{var}) was reported for the perforated plastic microfilm diameter of 320 mm with orifice diameter of 80 mm. The reported results showed that the perforated tube's discharges varied by about 58.66 % between their maximum and minimum values. Because of this, the discharge regulation of the orifices along the perforated tube was approximately 58.66 %, which was relatively lower than other values reported in the literature but similar to El-Awady et al. (2009).

Table 3. The evaluation results of pressure head and orifice discharge for the perforated plastic microfilm

Tube diameter (mm)	190		254	320	
Orifice diameter (mm)	20	40	60	60	80
H_{var} (%)	31.25	25.81	64.71	38.46	50.00
Q_{var} (%)	40.49	12.06	41.67	44.96	58.66

CONCLUSION

The main objective of this work is to study the possibility of utilizing plastic microfilm as a perforated tube for irrigation. Also, studying some factors that affect water uniformity distribution along perforated plastic microfilm tubes. Plastic microfilm tubes with different diameters of 190, 254, and 320 mm were investigated to use as perforated tubes for irrigation with orifices diameters 20, 40, 60, and 80 mm. The reported results showed that, the variation between the maximum pressure head and the minimum pressure head (H_{var}) along perforated plastic microfilm tube was about 31.25% and 25.81 % for the tube diameter of 190 mm with orifices diameter of 20, and 40 mm, respectively. The actual discharge of the orifices (Q_{act}) was nearly varied along the tube length. Meanwhile, the theoretical discharge (Q_{th}) dropped gradually in the tube and this dropping trend ended after that increased gradually until the tube ended. The discharge variation (Q_{var}) along perforated plastic microfilm tube was about 40.49% and 12.06% for the tube diameter of 190 mm with orifices diameter of 20, and 40 mm, respectively. The minimum value of the pressure variation (H_{var}) reported for the perforated plastic microfilm diameter of 190 mm with orifice diameter of 40 mm. While the maximum value of the pressure variation (H_{var}) was reported for the perforated plastic microfilm diameter of 254 mm with orifice diameter of 60 mm. The minimum value of the discharge variation (Q_{var}) reported for the perforated plastic microfilm diameter of 190 mm with orifice diameter of 40 mm. But the maximum value of the discharge variation (Q_{var}) was reported for the perforated plastic microfilm diameter of 320 mm with orifice diameter of 80 mm. From the reported results, it can be concluded that the perforated plastic microfilm can be used as a perforated tube for improving surface irrigation efficiency.

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اختبار وتقييم نظام أنابيب مثقبة باستخدام بلاستيك ميكروفيلم لتحسين الري السطحي

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الملخص

الهدف الرئيسي من هذا البحث هو دراسة إمكانية استخدام البلاستيك ميكروفيلم كنظام انابيب مثقبة للري. ولدراسة بعض العوامل التي تؤثر على انتظامية توزيع الماء على طول الأنبوبة المثقبة. تم استخدام أنابيب البلاستيك ميكروفيلم بأقطار مختلفة وهي ١٩٠، ٢٥٤، ٣٢٠ مم لاستخدامها كأنابيب مثقبة للري وتم عمل فتحات الري بأقطار ٢٠، ٤٠، ٦٠، ٨٠ مم. حيث أظهرت النتائج المتحصل عليها لقطر الأنبوبة ذات قطر ١٩٠ مم بشكل عام أن الضغط قد انخفض تدريجياً على طول الانبوب ثم بعد ذلك زاد الضغط المقاس تدريجيًا حتى وصل إلى نهاية الأنبوب. حيث تراوحت قيمة التباين بين أكبر وأصغر قيمة للضغط (H_{var}) على طول خط الانبوبة المصنوعة من البلاستيك ميكروفيلم المثقب حوالي ٣١,٢٥%، ٢٥,٨١% لقطر الأنبوب ١٩٠ مم وبفتحات للري بقطر ٢٠، ٤٠ مم على التوالي. وكانت قيم التصرف الفعلي للفتحات (Q_{act}) متغيرة على طول الأنبوبة بينما انخفضت قيم التصرف النظري المحسوب للفتحات (Q_{th}) تدريجيًا على طول الانبوبة ثم بعد ذلك زادت قيم التصرف النظري المحسوب للفتحات تدريجياً حتى وصل إلى نهاية الأنبوبة. حيث انخفضت قيم التصرف النظري المحسوب بسبب الفقد في الضغط بالاحتكاك ثم كان هناك زيادة تدريجية في ذلك بسبب زيادة الضغط الناتجة من التأثير العكسي عند نهاية الانبوبة. وكانت أصغر وأكبر قيمة لقيم التباين بين أقصى وأدنى قيمة الضغط (H_{var}) على طول الانبوبة المثقبة هي ٢٥,٨١ إلى ٦٤,٧١% بينما كانت للتباين في قيم التصرف (Q_{var}) هي ١٢,٠٦ إلى ٥٨,٦٦%.

الكلمات المفتاحية: الري السطحي، الأنابيب المبوبة، الأنابيب المثقبة، بلاستيك ميكروفيلم.