Evaluation the Hydraulic Performance of Drip Irrigation System with Multi Cases

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Abstract

Drip Irrigation Method is the best method that has been used in the world among the other irrigation methods because of its good and high uniformity. This method distributes water to the field using the pipe network and transforms it from the pipe network to the plant by emitters. In spite of the advantages of drip Irrigation method, the traditional network in drip irrigation method has many problems. The main problem is the drop in pressures and discharges distribution in the network resulting from the amount of pressure losses between the head of the lateral as compared with that in the end of the lateral. This drop affects the discharge distribution of emitters and uniformity. The research studies the improvement of emission uniformity of emitters by using new system layouts instead of the traditional system. The first proposed system layout concluded to improve the hydraulic performance by improving the pressure of distribution in the system by connecting the ends of the laterals together in the subunit. For further improvement, a carrier (close pipe convey the water) near the source to the lateral ends has been added to the looped network to represent the second proposed system (looped with carrier network) traditional network in drip irrigation method has many problems. The main problem is the drop in pressures and discharges distribution in the network resulting from the amount of pressure losses between the head of the lateral as compared with that in the end of the lateral. This drop affects the discharge distribution of emitters and uniformity. The research studies the improvement of emission uniformity of emitters by using new system layouts instead of the traditional system. The first proposed system layout concluded to improve the hydraulic performance by improving the pressure of distribution in the system by connecting the ends of the laterals together in the subunit. For further improvement, a carrier (close pipe convey the water) near the source to

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Index terms— drip irrigation, pressure, emitter, manufacture coefficient, carrier.

1 Evaluation the Hydraulic Performance of Drip Irrigation System with Multi Cases

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Author : College of Engineering -University of Babylon. E-mail : elhasnawi67@yahoo.com Abstract -Drip Irrigation Method is the best method that has been used in the world among the other irrigation methods because of its good and high uniformity. This method distributes water to the field using the pipe network and transforms it from the pipe network to the plant by emitters. In spite of the advantages of drip Irrigation method, the traditional network in drip irrigation method has many problems. The main problem is the drop in pressures and discharges distribution in the network resulting from the amount of pressure losses between the head of the lateral as compared with that in the end of the lateral. This drop affects the discharge distribution of emitters and uniformity. The research studies the improvement of emission uniformity of emitters by using new system layouts instead of the traditional system. The first proposed system layout concluded to improve the hydraulic performance by improving the pressure of distribution in the system by connecting the ends of the laterals together in the subunit. For further improvement, a carrier (close pipe convey the water) near the source to the lateral ends has been added to the looped network to represent the second proposed system (looped with carrier network).

The system is operated for ten different pressures (1.5 m to16m) with two emitter types were adopted at the field (orifice, and adjustable mini bubbler) are excluded since they failed to pass the manufacture variation test. At traditional network and proposed (looped) network. The hydraulic performance in the proposed (looped) network was better than the traditional network, and there is an improvement on the uniformity in the proposed (looped) network (11.38% to 15%).The mean relative percentage improvement in the emission uniformity for looped with carrier network as compared with looped network is (8.35%-9.02%).That means the third case batter than the other cases.

2 Introduction

rip irrigation (also known as trickle irrigation, micro-irrigation, or low-volume irrigation) offers an excellent alternative to sprinkler irrigation for vegetable and small fruit growers. Trickle irrigation systems typically use 30-50 percent less water than sprinkler systems and the water are rationed to the plants as they need it. This reduces evaporation, grower to only water the desired plants and not the row alleys or roadways. Weed control is therefore simplified, and workers are able to do fieldwork while the irrigation system is running. The system's almost continuous operation at low flow rates and operating pressures allow the grower to irrigate with lower-cost, smaller pumps through smaller, lightweight pipes which may deliver as little as 15 or 20 m3/m. The irrigation pumping requirement drops from the 7 to 4 m3/m per m2 at 50 to 40 psi typical for sprinklers to 5 to 2 m3/m per m2 at 20 to 6 psi for trickle irrigation systems. So 0.06 m3/m capacity water well solely dedicated to supplying 3 to 4 sprinklers may be used to trickle irrigate 2 to 4 acres of vegetables or small fruits, with enough extra capacity to meet normal household needs (Robert A. Schultheis, 2005). Drip irrigation systems can apply frequent and small amounts of irrigation water at many points of a field surface/subsurface near the plants (Youngs et al., 1999). (Al-Misned, 2000) found the estimation of energy losses due to emitter's connection in trickle irrigation laterals was very important. Since these losses had a direct effect on trickle irrigation system design, the study of these losses would lead to the improvement of system efficiency which would eventually result in conservation of water and energy. In his study, the problem of a lateral pipe with equally spaced emitters and uniform slope was evaluated. A computer program for estimating lateral discharge, emitter discharge and pressure head distribution along a lateral was developed. Individual emitters were considered in discharge and pressure estimations along the lateral starting from the downstream reach of the pipe. The friction head loss between successive emitters was estimated using Darcy-Weisbach, s formula. The change of the velocity head, the changes of momentum along the lateral, and the loss due to emitter were also considered. As the emitter discharge and energy losses were evaluated, the corresponding pressure head at each emitter was estimated accordingly. The output results from the program were in close agreement with the experimental data obtained from published work. The program provides a simple and direct method to design trickle laterals taking into account all energy losses including emitter's connection losses.

3 II.

4 Emitters

A rather exhaustive classification of emitters, their hydraulic and mechanical properties, and details of their construction are given by (Krystal and K. Zanker, 1974), (Keller and Karmeli, 1975). Emitters can be classified according to any one of several main particularly on hot, windy days, and enables the characteristics. Three categories were defined by (Krystal and K. Zanker, 1974): orifice drippers, long path type of drippers, porous tubing. Emitters are usually classified by the method in which they dissipate pressure or discharge characteristics (Keller and Bliesner, 1990).For example, there are long path, vortex, orifice, flushing, continuous flushing, and multi-outlet emitters. (Solomon, 1979) stated that the efficiency of trickle irrigation systems depends on the uniformity of emission rates throughout the system. An important factor affecting this uniformity is the unit-to-unit variation between emitters. The design of an emitter, the materials from which it is made, and the care taken in the manufacturing processes affects the amount of such unit-to-unit variation that may be expected. **??**VanceLeo, 2004) Evaluated the application uniformity of subsurface drip distribution systems and the recovery of emitter flow rates. Emission volume in the field and laboratory measured flow rates were determined for emitters from three locations and studied the effects of lateral orientation with respect to slope on emitter plugging. Two different emitters were tested to evaluate slope effects on emitter plugging (types Y and Z). The emitters were alternately spliced together and installed in an up and down orientation on slopes of 0, 1, 2, and 4% and along the contour on slopes of 1 and 2%. The emitters were covered with 3 soil and underwent a simulated year of dosing cycles, and then flushed with a flushing velocity of 0.6 m/s. Initial flow rates for the two emitter types were 2.38 L/hr with a coefficient of manufacture (Cv) equal to 0.07. There was no significant difference in flow rates among slopes for type Y emitters, but there was a significant difference between the 1% and 2 % contour slopes for type Z emitters. Application uniformity of three different laterals at each site was evaluated. Sections of the lateral from the beginning, middle and end were excavated and emission volumes were recorded for each emitter. Application uniformity of laterals ranged from 48.69 to 9.49%, 83.55 to 72.60%, and 44.41 to 0% for sites A, B, and C, respectively. Mean emitter flow rates were 2.21, 2.24, and 2.56 L/hr for sites A, B, and C, respectively under laboratory conditions. Application uniformity under laboratory conditions ranged from 70.97 to 14.91%, 86.67 to 79.99%, and 85.04 to 10.01% for sites A, B, and C, respectively. A flushing velocity of 0.15 m/s with no chlorination, shock chlorination of 3400 mg/L and flushing velocity of 0.15 m/s, and shock chlorination of 3400 mg/L and flushing velocity of 0.6 m/s treatment regiments were applied to all laterals collected to assess emitter flow rate recovery to the nominal flow rate published by the manufacturer. All laterals showed an increase in the number of emitters within 10% of the published nominal flow rates.

5 III.

Emission Uniformity Keller and Karmeli (1974) presented a design method to determine irrigation depth and interval, system capacity, emitter flow characteristics and uniformity, and hydraulic design considerations. Furthermore, they developed two formulas to estimate the design emission uniformity for trickle (drip) irrigation systems; these formulas are expressed as follows:

(1)

(2) Cv = manufacturing coefficient of variation of the emitter discharges when tested under the same pressure head, EU = design emission uniformity of a subunit, percentage, EU a = design absolute emission uniformity, percentage, qn= minimum emitter discharge in the subunit, lph, qa = average emitter discharge in the subunit, lph, qx = maximum emitter discharge in the subunit, lph, Merriam and Keller (1978) presented a rationale to evaluate uniformity of water application from trickle (drip) irrigation systems in the field and classified the systems on the bases of system uniformity. They expressed field emission uniformity as follows:

(3) Where: EU f = field emission uniformity expressed as a percentage q1/4 = average discharge of the emitters on quarter of the area receiving the least amount in the tested subunit, lph.

The general values of EUf for systems which have been in operation for one or more seasons are: greater than 90%, excellent; between 80% and 90% good; 70 to 80, fair; and less than 70%, poor.

Ascough and Kiker (2002) compared the uniformity of application of sprinkler, and trickle (drip) irrigation systems. They followed the standards and the method of the American Society of Agricultural Engineering (ASAE) to determine water distribution from the various systems. They concluded that the systems need to be properly maintained and operated, and Where: n = is 1 or the number of emitters per plant (S t S r /S e S 1) if more than one, showed that well-maintained and correctly-operated systems can achieve or exceed a distribution uniformity that is considered reasonable and acceptable. Ella et al. (2008) evaluated the effect of the hydraulic head and slope on water distribution uniformity of a trickle (drip) irrigation system developed by International Development Enterprises, IDE. They developed mathematical relationships to characterize the effect of slope and head on uniformity. Generated a mathematical model for water distribution uniformity as a function of either head or slope. Their results showed that water distribution uniformity is influenced by hydraulic head and slope.

Jahad (2010) conducted an experiment field to investigate the improvement of trickle (drip) emission uniformity when the ends of laterals are connected to each other and used four types of emitter. He concluded that the hydraulic performance of trickle (drip) irrigation systems can be improved by connecting the ends of the laterals together in a subunit (looped network) since such looping improves the pressure distribution in the network. Jafar (2011) conducted an experiment to evaluate an existing theoretical formula to predict design emission uniformity, compare the design emission uniformity with field emission uniformity, check the assumptions made when deriving the formula, modify it, and compare the results of the two formulas with field measurements. He included conducting two sets of experiments, the first set involved testing several types of emitters and investigating the relationship among operational pressure head, manufacturing coefficient of variation, and emitter's flow rate. The second set of experiments involved measuring actual emission uniformity of trickle irrigation systems. He concluded that for the tested emitters the distribution of emitter's discharges, when tested at the same pressure head, around their mean was not normal; it is sufficient to test the emitter at a given head and use the results to find the manufacturing emission uniformity; the values of emission uniformity calculated by an existing and a developed formulas indicated that the two theoretical methods gave results very close to the values obtained in the field. But, however, the developed formula to calculate the hydraulic emission uniformity does not require executing a comprehensive design for the trickle subunit.

IV.

6 Case Study

The main idea in the planning of the present work done in the field to study the pressure distribution and performance of the emitters on three proposed drip irrigation networks. The first is a traditional dead-end, the second proposed looped network and the third looped with carrier network .The traditional and proposed networks were operated at the same circumstances. Three different types of emitters were used in the field work the three cases with different pressures values.

V.

7 Field Work Layout

The water source is AL-Zabar Stream in Khagan Village in Babylon Governorate, 30:15:15 E, 44:40:30 N in the middle of Iraq and the maximum pressure level is 16m head. Water is provided by using a pump give a head of 20m with flow rate180 l/min). Behind the pump there is a filter (plastic filter type) and a valve to regulate and control the main discharge and main pressure head in the main line. The main line is a plastic pipe with 25mm diameter and one meter in length. The main pipe is divided into two manifold plastic pipes each is 25mm in diameter and 2.5m long. From the manifold two laterals with valves at the head and end of each lateral and there is air relief at the ends of the laterals. The lateral is polyethylene pipe 16mm in diameter and 15m long. The spacing between two laterals is 1.25m; the ends of the laterals are looped together by a polyethylene pipe 16mm in diameter. The main pressure gage is connected downstream the pump and upstream the controlling and regulating valve on the main pipe. Other pressure gages are connected at the head, middle, and the end of each lateral in the network. There are 13 gauges in total in the whole network. The traditional network is represented through the end valves enclosure while the proposed network is represented by opening the end valves for the laterals at case two and opening the end valves for the laterals and Five locations (emitter discharge locations) along each lateral are selected with a total of 20 locations for the whole system to evaluate field emission uniformity (EUf). The representative block of laterals is achieved by selecting the first third, second third and the last emitter on corresponding laterals in the block. The field test uniformity (EUf) is the ratio, expressed as a percentage, of the average emitter discharge for the lowest (1/4) of the field data to the average of all data. The average of the lowest (1/4) was selected as a practical value for the minimum discharge. (EUf) is calculated by using the following equation VII.

8 Field Results Comparison

Comparing the measured results in the network at three states, the difference in the pressures between the emitters along the laterals in the traditional network were greater than the difference in the pressures in the looped network, and looped with carrier network and the (EUf=100* ql /). The results are given in Fig. 3 and

9 Conclusions

From the comparison of field the following conclusions are drawn from this study: 1. The proposed looped with carrier network is better than the traditional network. 2. The mean uniformity in the proposed looped with carrier network is higher than the traditional network. 3. The pressure distribution along the laterals in the looped with carrier network is better than that in the traditional and looped network. 4. Clogging problems in the looped with carrier network are less than those in the traditional looped network, due to the rise in pressures at the emitters which are laid at the end of the laterals.

10 Global

Figure 1:

Figure 2:

1[redacted]

Figure 3: Figure 1 :

2[redacted]

Figure 4: Figure 2 :

4[redacted]

Figure 5: Fig. 4

3[redacted]

Figure 6: Figure 3 :

24[redacted]

Figure 7: 2 Figure 4 :

1

4.1 4.2 4.3 4.38 4.39 4.40
Manifold pipe Lateral pipe Looped pipe
3.1 3.2 3.3 3.38 3.39 3.40
Main pressure gauge
Main pipe Carrier pipe
Pump
Basin water Emitter No. Valve
2.1 2.2 2.3 2.38 2.39 2.40
Emitter Pressure gauge
1.1 1.2 1.3 1.38 1.39 1.40

Figure 8: Table 1 :

2

[Note: b) Field Test of Emission Uniformity (Euf Test)]

Figure 9: Table 2 :

No. of emitter	Type of emitter	Values of Cv	Evaluation of the emitters
I	Orifice emitter	0.056	Average
II	Adjustable flow dripper orifice emitter	0.058	Average

100
80
EU % 60 40
Looped with carrier
Looped
Traditional
20
0
6.1 7.5 9.2 11.2 13.4 14.9 16.4 17.3
Head (m)

Figure 10:

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