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Evaluation of Emitter Clogging in Trickle Irrigation with Wastewater

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ABSTRACT

Reuse of waste is an important environmental friendly technology especially in dry areas and metropolises where there is strong demand for water. The methods of trickle irrigation by wastewater can be useful via increasing the efficiency of irrigation and using less water. This research was conducted with the aim of studying the effect of waste water on emitter clogging in trickle irrigation. Experiments with the treatment of the type of emitter (4 types), the type of water (wastewater and water) and the system operating pressure (4 m and 10 m) was conducted with three repetitions. Online emitter (Netafim) and inline emitter (Drip), the 16 mm irrigation tapes with 20 cm and 30 cm row spacing were used. Operating pressure of irrigation system was 4 and 10 meters respectively. Treated wastewater and well water were used as a treatment and control respectively. The irrigation system with 30 meters lateral length was implemented and 22 times of irrigation was measured. The results showed that the wastewater and the number of times of irrigation have effects on emitter clogging. Water effluence uniformity in Netafim emitter was more than the other emitters. The highest amount of water effluence uniformity belonged to Netafim emitter with 85.47% and least amount was recorded for inline emitter with 70.39%. The highest percentage of flood reduction was 50% for inline emitter in line 16. In irrigation tapes, the water effluence uniformity for the spacing of 30 cm was more than 20 cm.
KEYWORDS: wastewater, trickle irrigation, clogging, emitter, operating pressure.

INTRODUCTION

The applications of wastewater reuse have been used frequently in agriculture. Most people afraid of using wastewater reuse due to the probable pollution [1]. According to the statistics of the year 1996, the amount of exotic water in Iran including municipal and industrial wastewater was 3.36 billion cubic meters/year, while 2.5 billion cubic meters of that belonged to municipal wastewater. The amount of the wastewater increased to 4.5 billion cubic meters in 2001 and it is predicted to rise to 7 billion cubic meters in 2011 [1]. The sewage effluent can be used in some cases like irrigation of green space dependent on the degree of pollution and the need to implement the process of treatment. According to the degree of treatment, sewage wastewater could be used for sprinkler, trickle or surface irrigation. Using effluent has been effective on the uniformity of effluence and discharge in drippers in trickle irrigation systems and this have impacts on the final cost, efficiency of water use, uniform effluence of water and the performance conditions of the system.The most significant stage in trickle irrigation is the efficiency of emitters in the uniform effluence of water, its durability and persistence against clogging, and it is believed to be the biggest executive problem in trickle irrigation systems[2].

In order to prevent physical clogging of the stilling basins, rotary separators (Hydrocyclone), sand filters and net filters are used. Less expensive acids like dilute Chloridric and Sulfuric acids can be used for preventing chemical clogging and chlorine compounds are applicable to prevent biological clogging [3].

The most common factors of clogging are sand particles, organic materials, the concentration of chemical sludge and sediments in the pores of emitters [4].

Emitters clogging causes inappropriate water effluence along the lateral pipe and as a result, it affects the uniformity of water usage and crop production as well [5]. Several factors like emitter clogging, pressure, irrigation water temperature, the coefficient of variation in build affect the emitters discharge. In order to prevent the occurrence of any type of clogging, special actions should be taken and the necessary management has to be applied [6,7].

In this research, the issue of emitters clogging for the conditions of using effluent wastewater instead of water, was studied. The influence of using treated waste water on low water uniformity of emitters in a time period of at least a cultivation period was investigated.

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MATERIALS AND METHODS

Two trickle irrigation systems for Irrigation with wastewater and well water were separately implemented in the research farm of the Faculty of Agriculture in Islamic Azad University of Mashhad. The implemented trickle irrigation system had a Manifold pipeline, main pipeline, pump, and the independent reservoir and in each lateral one type of the emitters was used. Lateral pipes were randomly used in each Manifold with the length of 30 m and online emitter (Netafim), inline emitter (Drip), Irrigation tapes (Type) 16 mm with output spacing of 29 cm and Irrigation tapes of 16 mm long with output spacing of 30 cm. In the beginning of each lateral pipe, a valve and a barometer were installed in order to measure the performance pressure of the emitters. Irrigation was done 22 times parameters were measured.

Manifold pipe and the laterals were installed on the stand at the height of 40 cm from the ground so that the gauges for measuring the volume of water could be placed under the emitters. The accumulated water was measured in 2 hours.

In this plan, two types of water, wastewater and well water were used. In order to study the trend of changes in discharge of the emitters under the influence of the quality of water in each experiment, the average discharge of the two emitters at the first third of each lateral was calculated through the measurement of the accumulated water in the gauges under the emitters in the time of performance.

The effluence uniformity is the most effective factor on the efficiency of water usage in trickle irrigation. In order to express the effluence uniformity, different criteria are used. Carmley and Clare presented relation 1 for the effluence uniformity [8].

$$EU = 100 * (qn/qa) \quad [1]$$

EU = effluence uniformity of emitters in per cent (%)

qn = the average of one fourth of the least discharge of emitters in liters per hour

qa = the average of discharge intensity of emitters in liters per hour

Also, the parameter of absolute effluence uniformity (EUa) that includes the average, maximum and minimum discharge value of emitters is calculated as the following [3]

$$EUa = 50 * ((qn/qa)+(qa/qx)) \quad [2]$$

EUa = the absolute effluence uniformity in per cent (%)

qx = the average of one eighth of the maximum value of emitters discharge in liters per hour

In addition to the water effluence uniformity, the changes in discharge have also been measured and shown as a trend of changes. The math equation of discharge reduction in time was calculated as regression for each type of emitter with the application of water and wastewater so that the approximate time of complete emitter blocking could be determined (with the conditions supposed to be constant).

RESULTS AND DISCUSSION

In this plan, the physical and chemical qualities, and the pollution of wastewater and the water used in the lab were measured. The results showed that there was a significant difference between the measured results and what was given as the criterion of quality for the output wastewater. For instance, the measurements during the period of this plan indicated that BOD5 had never been below 148 while the given data for the output wastewater was 86. Study on the tested parameters show that the output wastewater from the refinery was not standard and the process has not been done completely. In case of elimination of defects and standardization of the wastewater, the performance of the irrigation system increased by using wastewater.

The value of the effluence uniformity of the emitters for treated wastewater and well water during the experiment was calculated using equations 1 and 2 and the results are shown in table 1. It was seen that, the effluence uniformity of the emitters is affected by the factors of the water quality and the type of emitters. In other words, the effluence uniformity changes with both the change in water quality and the type of emitter.

Table1. The effluence uniformity and Absolute effluence uniformity of the emitters with the operating pressure and the application of water

It could be seen that Netafim emitter with the irrigation by well water had the highest value for the effluence uniformity during the period, 94 per cent in fact, while the effluence uniformity of this emitter was not more than 85 per cent with wastewater.

The effluence uniformity of water was changed considerably during the period of irrigation with wastewater. These changes was especially more significant in tapes with the exit of 30 cm compared with other treatments.

The amount of decrease in discharge in a period of time has been considered as a measure for emitter clogging. During the time of experiment, the amount of decline was also measured. As it was observed in Fig. 2 the highest amount of decrease in discharge, related to wastewater with tapes of 30 cm, was resulted in the operating pressure of 10 m, and the least for the same emitter was measured by using water, 8.5 per cent in fact. The results showed that in all four emitters, using wastewater has caused clogging and therefore the discharge will decrease over the time.

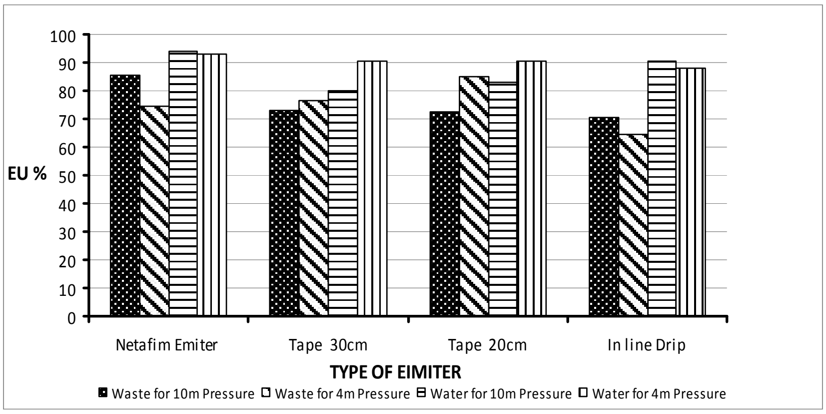

Figure1. Changes in the effluence uniformity for emitters with operating pressure in the application of water and wastewater.

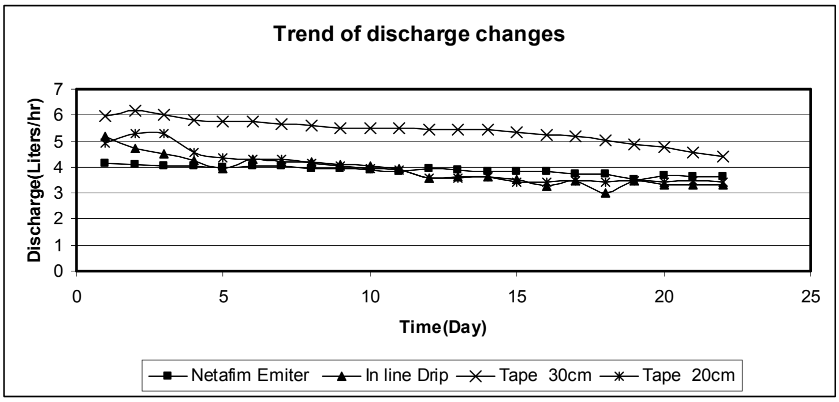

Figure2. Trend of decrease in discharge of the emitter during the experiment period (22 times of irrigation)

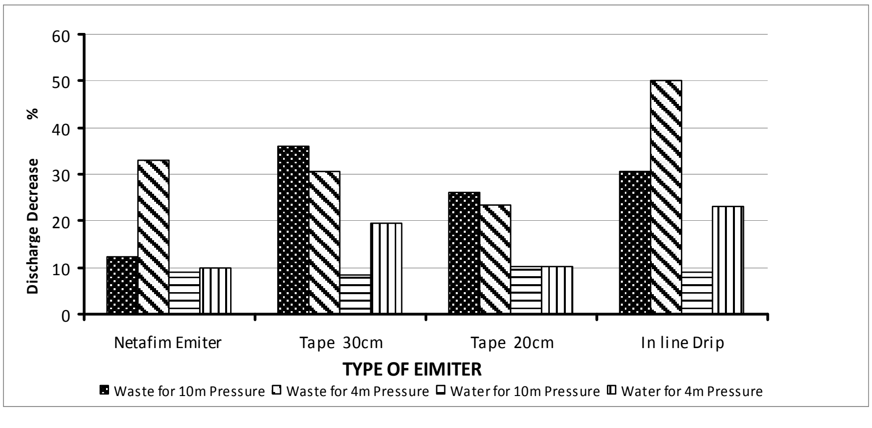

Figure 3. The percentage of decrease in discharge of emitters during the experiment period (22^{nd} week compared with 1^{st} week of irrigation)

According to figure 3, in the operating pressure of 10 m, the highest amount of discharge decrease was related to the wastewater used for the tapes of 30 cm (36%) and the least amount for the same emitter was 8.5 percent and was related to using water. The decrease in operating pressure from 10 to 4 meters has resulted in changing the discharge decrease from 36 to 30 percent. This decrease showed that the appropriate pressure for the irrigation tapes was less than 10 meters. For the Netafim and In-line emitters the conditions are the opposite and discharge decrease for the pressure of 4 meters was more than the operating pressure of 1- meters. In this type of emitters, the operating pressure should not be considered less than 10 meters.

Table1. The effluence uniformity and Absolute effluence uniformity of the emitters with the operating pressure and the application of water

Kind of water	Wastewater		Well water	
Kind of emitter	EU	EUa	EU	EUa
Netafim	85	85	98	94
Irrigation tapes with 20 cm row spacing	70	73	82	80
Irrigation tapes with 30 cm row spacing	66	72	81	83
Inline 16 mm emitter	75	70	91	90

The results showed that using wastewater caused clogging and therefore the discharge was decreased over the time. The trend for all four types of emitters was drawn and the outcome data indicated that the slope of discharge decrease in irrigation tapes with pores of 20 and 30 cm was more than the other two types of emitters. Considering the same circumstances at the time period of irrigation, the blocking time has been calculated. The results for the irrigation with wastewater showed that the complete blocking will occur in irrigation tapes with pores of 30 cm, and in Netafim emitters, after 60 and 175 times of irrigation, respectively. By using well water with these emitters, the complete block happens after 336 and 1050 times of irrigation, respectively.

Conclusion

Based on the results of qualitative analysis of used wastewater, it could be concluded that these parameters have significant difference with the results given by the refinery. The quality of the output wastewater was variable and a secondary treatment was needed.

When the type of water and emitter was changed the effluence uniformity changed. In comparison with the two types of water (wastewater and well water), the wastewater has more influence on the reduction of the effluence uniformity of the emitters. On Line emitters (Netafim) have higher effluence uniformity and lower discharge decrease. Therefore, this type of emitter was better used when the wastewater applied.

Since the most common factor of clogging in wastewater is algae, In Line emitters showed more sensitivity due to the passing of water current through the two layers of the emitter and have the highest percentage of decrease in discharge. There were solid particles and algae in wastewater, so the velocity and pressure were really important. Accurate calculation of these factors could increases the efficiency of emitters. For on-line and in-line emitters, operating pressure of 10 meters was more appropriate. The results showed that in trickle irrigation with the application of wastewater, it was much better to use a frequent system of irrigation with water and wastewater, so that emitters clogging will reduce.

The results showed that operating pressure and physical treatment significantly affect the emitters clogging, so choosing the pump and treatment system should be done carefully in trickle irrigation with wastewater. Also, sand filters with automated washing part, while using wastewater, was necessary and will certainly reduce the emitter clogging.

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