CONTRIBUTION OF TRICKLE IRRIGATION TECHNIQUE ON SUSTAINABLE AGRO-ENVIRONMENT: EVALUATION OF DRIPPER FLOW RATE

Ahmet Rasih İNCİMAN

Bilal ACAR

Agriculture has known single maximum good quality water user sector through the world. In that reason, current water resources have to be used with high efficiency especially in regions having arid or semi-arid climates (Ascough and Kiker, 2002). Irrigation is one of the most important inputs resulting high and qualified yield among the other farming activities for sustainable agro-production in dry or hot environments since rainfall is not sufficient and not uniformly distributed through the years in such climates.

It is obvious that, Irrigation is necessarily prerequisites to get economical crop yield in water scant regions. As known that agro-production is obtained from irrigated lands mostly.

In irrigated farmlands, the reason of low crop yield is mainly poor management of irrigation systems. In other words, there is a direct relationship between quality of irrigation system management and crop yield (Sener and Albut, 2011).

One of the most important issues in irrigation is application of water to the crops as uniform as possible. The drip irrigation system has many advantages over other traditional irrigation techniques such minimum labor requirement in irrigation process as well as adequate water delivery to the crops (Jalal and Acar, 2018; Narayamoorthy et al., 2018)

Beside those, water application efficiency is greater in drip irrigation technique under correct water management by comparing other irrigation systems (Quezada et al., 2011).

Water distribution uniformity has affected from multiple sources such as field slope, type/s of the system design and even management quality of the systems (Acar and Yılmaz, 2018).

Fluctuations in working pressures in pipe lines, complete or partial blockage of emitters and poor or lack of experiences of farmers about irrigation water management at field scale are possibly main causes of low water delivery performance of trickle irrigation systems (Zamanian et al., 2014).

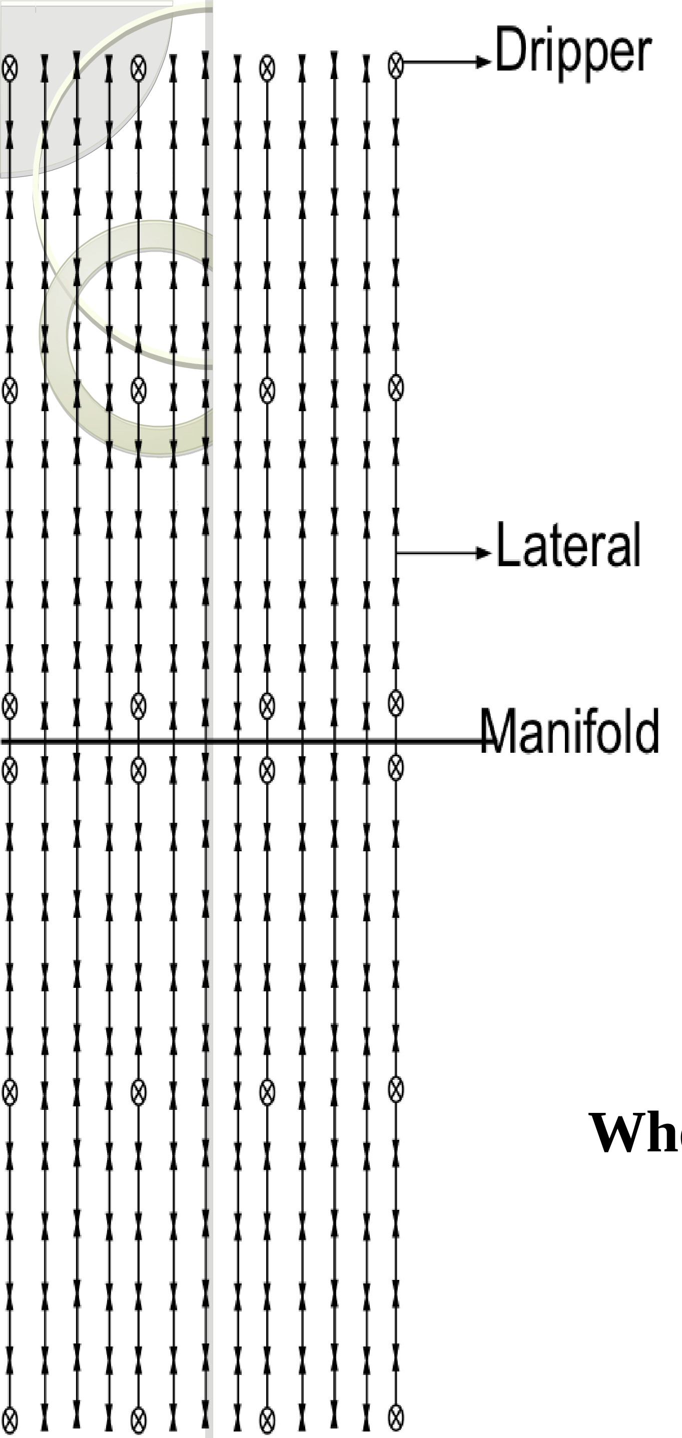
Water delivery performance of drip system is negative affected from the emitter blockage in most (Yavuz et al., 2010).
Drip irrigation system is well adapted for deficit irrigation by some field crops such as sugar beet, maize, potato and sunflower so on in areas where the current water resources are scant.

About 25% deficit irrigation by drip system, recommended for water shortage environments, has not resulted significant yield reduction by comparison to full irrigation treatments for those crops (Acar et al., 2014).
The selections of the lateral and manifold diameter with satisfactory are two important design parameters for obtaining well water delivery performance at drip system. Those diameters should be for yielding at least uniformity coefficient (UC) of 98% and 97.5%, respectively (Yıldırım ve Apaydın, 1999).
Water distribution uniformity of emitters can be evaluated via computing UC and Emission Uniformity, EU, in which are two well-known performance indicators in micro irrigation systems (Subramani and Prabakaran, 2015).

The aim of the present work is, therefore, to evaluate water delivery status of drip irrigation with detail by using findings from past studies and to give brief and useful practical recommendations resulting better irrigation efficiency for drip irrigation system designers, managers and farmers.

INTERPRETATION OF EMITTER FLOW RATES

The best emitter performance is obtained from flow measurements in whole emitters. Doing that is time consuming and not practical especially for drip irrigation systems at large-sized farmlands. Water volume is measured on drippers at start, middle, and end of each lateral at main or sub-main lines for a known period. About at least 24 or 36 drippers are assumed reliable for field test. In collection of water volume, small holes are established just under test emitters, and water-collecting cups are placed into those holes. Ruled plastics / glass cylinders are preferred for measurement processes of collected water within the catch cans. Having measured volumes of water obtained from those emitters, then data are converted to emitter flow rates as L/h (Mostafa and Thörmann, 2013).



In this paper, two common water delivery performance indicators namely UC and EU were examined.

UC can be computed by following equation (Capra and Tamburina, 1995):

$$UC = \left[\left(1 - \left(\frac{\Delta q}{q_{avr}}\right)\right) \right] \times 100$$

Where

UC; Uniformity coefficient, %,

Δq; Average of absolute deviation from average dripper flow rate, L/h,

$\mathbf{q_{avr}}$**;** Average dripper flow rate, L/h.

In accordance of UC, water delivery class can be determined by use of Table 1 (Tuzel, 1993).

Table 1. Water delivery class in accordance of UC

UC (%)	Emitter Flow Performance
> 90	Perfect
80 – 90	Well
70– 80	Fair
60 – 70	Poor
< 60	No-Acceptable

EU can be computed by following equation (Keller and Karmeli, 1974):

$$EU = \frac{q_{\%25}}{qavr} x100$$

Where

EU- Emission uniformity, %,

$q_{\%25}$- Average of the lowest quarter of the dripper flow rates, L/ h

q_{avr} - Average emitter discharge rate, L /h.

In regard to EU values, water distribution uniformity can be classified by use of Table 2.

Table 2. Water delivery class in accordance of EU

EU, %	Emitter Performance by (Merriam and Keller ,1978)	Emitter Performance by (Anonymous, 1983)
<70	Poor	No-Acceptable
70–80	Acceptable	Poor
80–86	Well	Acceptable
86–90	Well	Well
90–94	Perfect	Well
>94	Perfect	Perfect

FINDINGS OF SOME STUDIES

Camoglu and Yavuz (2004) examined UC and EU by testing National / Turkish and foreign lateral tubes. They found those parameters for National and Foreign laterals as 97% and 96%; and 98% and 97%, respectively. In accordance of those findings, the results were satisfactory.

Ascough and Kiker (2002) performed research about determination of UC and EU values by using five laterals namely second lateral of start, laterals at a quarter, half, three-quarter distances as well as second to final lateral. They examined five emitters at start of lateral, at a quarter, half, three-quarter length and end of lateral in each lateral with a total of 25 emitters. They found UC as 82% (**Well** Water Distribution) and EU as about 76% (**Acceptable** / **Poor** Water Distribution), respectively.

Yavuz et al. (2010) examined the water delivery performance of drippers mounted at laterals having ages of new, one year, two year and three year old obtained from the different farms at Canakkale province of Turkey. Having taken the sample laterals from the farmlands, they performed measurements of water volume from the emitters at initial, 1/3, 2/3, and end of the laterals by application of 100 kPa pressure head. They found UC values for new, one, two and three year old laterals as about between **99%and 96%**, between **99% and 98%**, between **99% and 71%**, and between **95% and 74%**, respectively. The EU values for same ages varied from 98.12% to **95.77%**, from **98.41%** to **96.97%**, from **97.91%** to **70.52%**, and from **90.23%** to **60.72%**, respectively.

After usage of three years, emitter delivery performance reduced due to the partial or complete plugging or damages of lines and emitters.

Acar et al. (2015) performed field tests at drip irrigation systems at 10 different olive farms located in Izmir province of Turkey. They found that **UC** varied **from 52% to 85%** and water distribution class were as **No-Acceptable** and **Well** in accordance of such UC values. **EU** varied **from 23% to 82%** and water distribution uniformity was **Poor** and **Well** in accordance of EU. They stated possible reasons of poor water distribution uniformity were laterals in some farms have used for long period or pipe networks were damages so high seepage losses were observed in those gardens.

Acar et al. (2009) researched UC at drip irrigation systems for 11 green houses in Antalya-Turkey. In such study, they found **UC** as between **62% and 95%.** They stated that water distribution uniformity is highly affected from the age of the lateral tubes, quality of the system design and level of management processes.

Subramani and Prabakaran (2015) studied about determination of UC and EU at Arriyanoor village belonging Salem, Tamilnadu, India. They determined UC and EU values as about **81% and 69%** , respectively.

Arya et al. (2017) investigated UC and EU for two agro-production houses namely Air Ventilation (AV) and Climate Controlled (CC) at 2013-2014 and 2014-2015 in India. They obtained good findings of UC about 94%, 93% for NV and 96%, 95 % for CC for periods mentioned above, respectively. They calculated EU values as about 90%, 89% for AV and 93%, 92% for CC for production years of 2013-2014 and 2014-2015, respectively.

Elamin et al. (2017) performed a laboratory test for determination of water delivery performance of three different type of drippers (A, B, and C) at Khartum-Sudan in 2015. The A and B drippers were pressure compensating while C dripper none-pressure compensating. A and B drippers are 4 L/h flow rate and C (no-pressure compensating) is 8 L/h flow rate. They considered total 90 emitters for the each test. They calculated UC and EU for water delivery analysis. They examined three different operating pressures namely 0.5, 0.75, and 1.0 bar in period of test.

They stated that types of the emitters had direct effect on water delivery performance of drip irrigation system. Water distribution uniformity was found greater for using pressure compensation emitters like A and B.

Table 3. Water delivery status of examined drippers (Elamin et al. (2017).

Drippers	UC, %	EU, %
A	95	93
B	92	88
C	86	81

There is no doubt that drip irrigation is an efficient method for water savings under well management. Thus, using that system for irrigation of large areas will result improvement of irrigation efficiency. I
n that regard, drip irrigation system is environmentally friendly especially for water shortage environments

Emitters are the most important component of the drip irrigation systems and performance of those can be affected from the various factors. Poor performance of drip irrigation system can be resulted from some factors such as low quality of irrigation water, inadequate system design, installation of such system in the field by none-experienced staff and lack of maintenance-repair works.

To achieve the maximum benefits from the drip irrigation systems following recommendations should be considered:

1. The system components of drip irrigation systems should be good quality (if possible)
2. Skillful labor/s should install that irrigation system in farmlands
3. The lengths of laterals should be in accordance of charts of production company
4. Filter should be used in systems in case irrigation water having some particles resulting emitter clogging

5 If the field topography is highly undulating or steeper slopes, pressure compensating drippers can be suggested.

6 If the water resources are very scant, subsurface drip irrigation system is a practical solution for minimizing the water losses by evaporation or maximize the irrigation efficiency.

7 Farmer should be trained about agricultural water management. It can be noted that irrigation method is important but possibly the most important thing is management of the irrigation systems for sustainable crop production

THANK YOU FOR LISTENING