

WATERING UNIFORMITY OF DRIP IRRIGATION SYSTEMS USING IN IRRIGATION OF MAIZE FOR KONYA-ÇUMRA PROVINCE, TURKEY

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Abstract

This study was conducted to determine water distribution uniformity of emitters at different drip irrigation systems using at maize farms in Çumra region of Konya, Turkey. Watering performance of drippers was classified by using two criteria namely Uniformity Coefficient, UC, and Emission Uniformity, EU. In results, UC varied from 68% to 84% with an average of 75% and water delivery class was 'Moderate' in accordance of such a mean value. EU varied from 44% to 71% with an average of 55%, and watering performance was 'Poor' or 'Unacceptable' in regard to average of EU value. Variations in emitter discharge rates in all examined drip irrigation systems were found higher than 10%. Drip irrigation system should be designated in accordance of hydraulic principles, installed by experienced people and timely maintenance-repair works are needed for maximizing water distribution uniformity consequently improvement grain/silage yields as well as more economical returns.

Key words: maize, drip irrigation systems, watering efficiency of drippers

Agriculture is huge fresh water user sector worldwide. As we know that irrigation is backbone input for increasing crop yield, and productive utilization of water resources are great interests particularly in regions having water scarcity (Hanson and May, 2007; Acar *et al.*, 2014; Yavuz *et al.*, 2017).

In water shortage environments, pressurized irrigation techniques are very efficient in respect to well crop developments, and yield consequently better economical returns. It is possible for farmers to obtain high water, energy, and fertilizer savings in such irrigation systems under proper water management (Şimşek *et al.*, 2004; Zamanian *et al.*, 2014; Yavuz *et al.*, 2015 a,b; Yavuz *et al.*, 2016; Yavuz *et al.*, 2019; Santana Junior *et al.*, 2020).

Drip irrigation, one of the pressurized irrigation systems, has allowed to more uniform water application through root zone depth with greater water economy consequently optimal crop yield. Pressure variations within laterals have direct effect on water delivery efficacy of drippers (Mohanty *et al.*, 2016).

In recent years, corn production has increased step by step due to resulting better income for farmers at Konya region, Turkey. It is impossible for producers to obtain economical income without irrigation in such environment even for winter cereals. In recent, drip irrigation system has used for irrigation of corn with an

increasing trend. Yavuz *et al.*, (2018) stated that full or irrigation at whole plant growth stages has resulted optimum yield and quality so such strategy could be highly beneficial particularly in environments having plenty water supplies.

Drip irrigation system has caused more water economy, possible to reach up to 90 or 95% water application efficiency, and manpower savings (Amoo *et al.*, 2019; Patil and Patil, 2019; Selvaperumal *et al.*, 2019; Trivedi and Gautam, 2019), and is also possible to use water more productive with deficit irrigation by drip irrigation system (Attila *et al.*, 2019).

The main goal of irrigation activity is application of water to crops as uniform as possible. The flow variations among emitters should be little (less than 10% of acceptable range) to accomplish adequate water uniformity a cross to irrigated fields (Omofunmi *et al.*, 2019; Trivedi and Gautam, 2019).

In drip irrigation system design, emitter spacing and wetting front are paramount useful information for obtaining optimal water content within root zone. The wetted volume, mainly depending on soil properties, is amount of available water for plants e.g. maximal width and depth of wetting advance were determined as 0.35 m and 0.56 m, respectively for sandy-loam soil under usages emitter with flow rate of 1.3 and 3 L/h (Mirjat *et al.*, 2010).

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Correct design, installation, timely maintenance-repair works such as well filtration of irrigation water and proper management of drip irrigation systems are very important role to play for obtaining satisfactory water delivery performance (Hanson and May, 2007; Mostafa and Thörmann, 2013; Cannan *et al.*, 2020). Among those, clogging and huge pressure variations in pipe networks are two common problems causing fluctuations in water level (Trivedi and Gautam, 2019). Amer and Gomaa (2003), found UC values as almost 92%, 94%, and 94% for 2% upslope, zero slopes, and 2% downslope, respectively; EU values as around 79%, 84%, and 88%, respectively for similar slopes. Yavuz *et al.* (2010) found mean UC values of 98% and 80%, and EU values of 97% and 73% for none-used and aging-laterals, respectively under 100 kPa pressure head. Omofunmi *et al.* (2019) found both UC and EU as about 99%, respectively; consequently, system was perfect designated.

In research region, Konya-Çumra, none study was performed about assessment of water uniformity under drip irrigation systems using for corn irrigation. The aim of the study, therefore, was to research water application uniformities in corn farming under drip irrigation systems.

MATERIAL AND METHOD

This study was carried out at Çumra province belonging to Konya city of Turkey. The research area, situated at Middle Anatolian Region, is 1013 m above sea level and has popularity in productions of cereals, sugar beet, corn, alfalfa, dry bean, sunflower and some vegetables such as carrot, pepper, tomato, and lettuce. The region has semi-arid climate and almost 40% of precipitation has observed during crop growth period (Yavuz *et al.*, 2014).

Water distribution uniformity of drip irrigation systems was evaluated by measuring volume of collected water from some emitters on selected laterals. In position of water inlet representative three laterals situated at initial, middle, and far or end on manifold were used. The emitter flow rates were between 1.9 and 2.6 L/h. About 36 plastic containers having capacity of 200 ml were placed just under selective emitters on those three lateral lines (each lateral had 12 measurement points). Then, drip irrigation systems were run about 10 or 15 minutes. After all drops ended in drip irrigation system, water volumes within plastic cups were measured by using graded cylinder and then they were converted to unit of L/h as suggested by Mostafa and Thörmann (2013).

Emitter performance was determined by using Uniformity Coefficients UC, and Emission Uniformity, EU.

UC was calculated by (Capra and Tanburina, 1995):

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

where, UC- Uniformity Coefficient, %, Δq – Mean of absolute deviation from mean emitter discharge, L/h, and q_{mean} – Mean emitter discharge, L/h. Emitter watering performance, EWP, was classified by using *table 1* (Tüzel, 1993).

Table 1

| Relationships between UC and EWP | |
|----------------------------------|-----------------------------------|
| UC (%) | Emitter watering performance, EWP |
| > 90 | Very Well |
| 80 – 90 | Well |
| 70– 80 | Moderate |
| 60 – 70 | Poor |
| < % 60 | Not Acceptable |

EU was calculated by (Keller and Karmeli, 1974):

$$EU = \frac{q_{25}}{q_{mean}} \times 100$$

where; EU - Emission uniformity, %, q_{25} - Mean of the lowest quarter of the emitter discharge, L/ h. In regard to EU values, water distribution quality was classified by use of *table 2*.

Table 2

| Relationships between EU and EWP | | |
|----------------------------------|----------------------------|-------------------|
| EU (%) | EWP | EWP |
| | (Merriam and Keller, 1978) | (Anonymous, 1983) |
| <70 | Poor | No-Acceptable |
| 70–80 | Acceptable | Poor |
| 80–86 | Well | Acceptable |
| 86–90 | Well | Well |
| 90–94 | Very Good | Well |
| >94 | Very Good | Very Good |

RESULTS AND DISCUSSIONS

Characteristics of pipes of drip irrigation systems were presented at *table 3*. In examined drip irrigation systems, main, manifold and lateral diameters varied from 110 mm to 175 mm; from 90 mm to 125 mm and from 22 mm to 25 mm, respectively. In general lateral length was measured as 250 m with emitter spacing of 25-30 cm.

The maximum UC was determined as 84% and performances of drippers was **well** in regard to such value. However, minimum UC was determined as 68% and emitter water application performance was classified as **poor**. In general, water distribution performance was **moderate** in current study.

UC values reported as about 94% by Amer and Gomaa (2003), 98% for new or 80% for using three-year lateral by Yavuz *et al.* (2010), 82-87% by Mirjat *et al.* (2010), 98% for on-line and 97%

for in-line drippers by Popale *et al.*, (2011), 44%-99% by Acar and Yılmaz (2018); 62%-95% by Acar *et al.*, (2009); 52-95% by Acar *et al.*, (2015), 78-99% by Ünal *et al.*, (2015), 95% by Arya *et al.*, (2017), around 99% by Omofunmi *et al.*, (2019) and almost 98% by Sadatiya *et al.*, (2019). The finding of current study was as an average of 75%, and is almost agreement with Acar *et al.*, (2009), Acar *et al.*, (2015), and Acar and Yılmaz (2018) but lower than results of somewhere else (Amer and Gomaa, 2003; Yavuz *et al.*, 2010; Mirjat *et al.*, 2010; Popale *et al.*, 2011, Ünal *et al.*, 2015; Arya *et al.*, 2017; Omofunmi *et al.*, 2019; Sadatiya *et al.*, 2019).

Table 3

Pipe components of drip irrigation systems

| Farms | Main line (mm) | Manifold (mm) | Lateral tube (mm) | Lateral length (m) | Emitter spacing (cm) |
|-------|----------------|---------------|-------------------|--------------------|----------------------|
| 1 | 125 | 125 | 22 | 247 | 30 |
| 2 | 175 | 125 | 25 | 250 | 25 |
| 3 | 175 | 90 | 25 | 250 | 25 |
| 4 | 175 | 125 | 25 | 250 | 25 |
| 5 | 175 | 125 | 25 | 230 | 25 |
| 6 | 110 | 90 | 25 | 250 | 25 |
| 7 | 110 | 90 | 25 | 250 | 25 |
| 8 | 125 | 125 | 22.5 | 250 | 30 |
| 9 | 175 | 125 | 22.5 | 250 | 30 |
| 10 | 175 | 125 | 25 | 250 | 25 |
| 11 | 175 | 125 | 22.5 | 250 | 30 |

EU values were maximum as 71% and minimum as 44% with mean of 55%. In result, almost all drippers had as **poor** or **no-acceptable** performance. In that regard, it is possible to say that drippers resulted none-uniform water application for maize crops.

In some previous studies about EU values; about 75% by Soccol *et al.*, (2002), 84% by Amer and Gomaa (2003), 97% for brandy or 73% for used 3-year lateral by Yavuz *et al.*, (2010), 75-81% by Mirjat *et al.*, (2010), 97% for on-line and 99% for in-line drippers by Popale *et al.*, (2011), 23-99% by Acar and Yılmaz (2018), 23-82% by Acar *et al.*, (2015), 65-99% by Ünal *et al.*, (2015), and 91% by Arya *et al.*, (2017), about 99% by Omofunmi *et al.*, (2019), and around 96% by Sadatiya *et al.*, (2019). Our finding of mean 55% is almost conformity with Acar and Yılmaz (2018), and Acar *et al.*, (2015), but not-agreement with Soccol *et al.*, (2002), Amer and Gomaa (2003), Yavuz *et al.*, (2010), Mirjat *et al.*, (2010), Popale *et al.*, (2011), Ünal *et al.*, (2015), Arya *et al.*, (2017), Omofunmi *et al.*, (2019), and Sadatiya *et al.*, (2019).

In general, reasons of low watering uniformity in present study may be resulted from using age-distribution lines, narrower emitter spacing, and use of longer laterals, partial or

complete clogging in some emitters, and improper maintenance-repair works in systems.

CONCLUSIONS

In general, water distribution class was far from expectations since variations between the emitter flow rates were greater than the 10% in which is low acceptable threshold level for micro irrigation system. The reasons behind low water distribution efficiency could be as follows: poor design and installation of systems, preferences of laterals with longer lengths and narrower dripper spacing, improper selections of water delivery pipes, poor maintenance-repair works consequently great pressure variations through systems.

Proper design and installation as well as correct management of drip irrigation systems are vital important for accomplishing satisfactory water distribution uniformity. Farmers should be trained about efficient management of such system. It is obvious that drip irrigation system has led to savings in water and plant nutrients so farmlands having such systems should be widen particularly at water scant environments for sustainable utilization of current water resources.

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