Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.6759

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (5):** 702-707 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Hydraulic Performance of Micro Irrigation Systems to Be Installed on Tulsi Tank

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Received: 1.08.2018 | Revised: 30.08.2018 | Accepted: 7.09.2018

ABSTRACT

The field experiments were conducted to evaluate the hydraulic performance of drip irrigation systems to be installed on Tulsi Tank at Surgi Village, Rajnandgaon 2017-18. The performance of drip system was evaluated on the basis of parameters like average emitter discharge (Qavg), Emission uniformity (EU_f), uniformity coefficient (U_s), Coefficient of manufacture's variation (C_v) and Emitter flow variation (Q_{avg}), at two different pressure 0.8 and 1.0 kg cm^{-2}. Average emitter discharge, Emission uniformity (EU_f), uniformity coefficient (U_s), Coefficient of manufacture's variation (C_v) and Emitter flow variation (Q_{avg}) were found (1.06 l h^{-1}, 87.53%, 86.75%, 0.13 and 37.70% respectively) at 0.8 kg cm^{-2} operating pressure and (1.15 l h^{-1}, 90.54%, 88.48%, 0.11 and 20.0% respectively) found at 1.0 kg cm^{-2}. Result shows that the discharge flow rate of emitter is increased when the increase of the pressure and the coefficient of variation is increased when the pressure is decreased means the pressure directly affected the discharge rate of emitter. Hydraulic performance of drip irrigation system found good and needs to be operated at 1.0 kg cm^{-2} pressure for 1.3 l h^{-1} inline emitter.

Key words: *Drip Irrigation, Emitter discharge, Emission uniformity, Uniformity coefficient, Coefficient of manufacture's variation, Emitter flow variation.*

INTRODUCTION

Efficient use of available irrigation water is essential for increasing agricultural productivity for the alarming Indian population. As the population of India is increasing day by day, the pressure on agriculture is increasing in the same way[1]. For an efficient irrigation, water has to be uniformly applied to the crop field. The emitter device is the main component of a drip irrigation lateral and determines the drip irrigation capacity[3]. The drip irrigation is one of the efficient micro irrigation system. It applies the water directly to the root zone as per the crop requirements. With the help of the drip irrigation it is easy to control the water applications matching the temporal variability of the crops water requirements.

Cite this article: Chandrakar, A. and Pandey, V.K., Hydraulic Performance of Micro Irrigation Systems to Be Installed on Tulsi Tank, *Int. J. Pure App. Biosci.* **6(5):** 702-707 (2018). doi: http://dx.doi.org/10.18782/2320-7051.6759

The drip irrigation has several advantages over the rest methods of the irrigation but its adoption requires technical knowhow in selection of types of system, its components, design, installation, operation and maintenance. Drip irrigation is a very efficient method of supplying water to plants. Sprinkler irrigation is 55-70% efficient whereas drip irrigation is 90% efficient. Sometimes called trickle irrigation, drip irrigation supplies water close to the soil surface, reducing the chance of evaporation. This slow rate of water flow allows time for the water to soak into the soil resulting in less likelihood of runoff. Drip irrigation has advantages as this system produces a higher ratio of yield per unit area and yield per unit volume of water than any other surface or sprinkler irrigation system, no interference with cultural practices and improved cultural practices, allows field operations even during irrigation, saving in fertilizer and labour, less nutrient & chemical leaching and deep percolation, reduced weed germination and their growth, reduced pest and disease damages due to drier and less humid crop canopies, warmer soils, no soil crusting due to irrigation, and well suited to widely spaced crops[6].

The present study was conducted to studies on hydraulic performance of micro irrigation systems to be installed on Tulsi Tank.

MATERIAL AND METHODS

Study area

Field experiment was carried out during the year 2017-18 in winter season at Surgi Village.Surgi village is located in Rajnandgaon Tehsil of Rajnandgaon district in Chhattisgarh, India. It is situated 13 km away from Rajnandgaonat Longitude 81.10^0 E, Latitude 21.02^0 N and at an Altitude of 307 meters above the mean sea level.

Performance of drip irrigation system

Measurement of discharge from emitters

Emitters having discharge capacity i.e.1.3 l h^{-1} were tested at different operating pressure i.e. 0.8 and 1.0 kg cm^{-2} and these pressures are maintained by using control valve at head control unit and inlet of each lateral. The operating pressure head was measured by pressure gauge. Water was collected from drippers to confine the discharge into the plastic container directly. Irrigation water was supplied from a Tulsi Tank, filtered through disc filter. Test times varied with pressure and drippers used and converted into discharge per hour. Water collected in containers was measured with the help of measuring cylinder.

Coefficient of manufacturer's variation

Coefficient of variation (Cv) is a statistical parameter expressed as

$$C_v = \frac{s}{q_{avg}} \quad \ldots (1)$$

Where, s is standard deviation of flow and q_{avg} is the mean flow for a samplednumber of emitters of the same type tested at a fixed pressure.

A parameter which can be used as a measure of emitter flow variation caused by variation in manufacturing of the emitter is called the coefficient of manufacturing variation (Cv).

Emission uniformity (EU_f)

Emission uniformity is needed for calculating the gross depth of irrigation, irrigation interval and required system capacity. The following equation is commonly used to estimate the design emission uniformity in point source and line source drip irrigation system.

$$EU_f = \frac{q_n}{q_{avg}} \times 100 \quad \ldots (2)$$

Where,

EU_f = field test emission uniformity, percentage

q_n = average of the lowest 1/4th of the field data emitter discharge, l h^{-1}

q_{avg} = average of all the field data emitter discharge, l h^{-1}

Emitter flow variation (Q_{var})

It consists of finding the minimum and maximum pressure in the sub-units and calculating the emitter flow variation (Q_{var}) as follows.

$$Q_{var} = 100\left[1-\frac{Q_{min}}{Q_{max}}\right] \quad \ldots (3)$$

Where,

Q_{var} = emitter flow variation in percentage

Q_{min} = minimum emitter discharge rate in the system, l h^{-1}

Q_{max} = design emitter discharge rate, l h^{-1}

Statistical uniformity coefficient (U_S)

Statistical uniformity coefficient given by the equation

$$U_S = 100\left(1 - \frac{S_q}{Q_{avg}}\right) \quad \ldots (4)$$

Where,

U_S = statistical uniformity coefficient (%)

S_q = standard deviation of emitter flow

q_a = mean emitter flow

RESULTS AND DISCUSSION

The various parameters to evaluate the performance of drip irrigation system at different pressures viz.,average emitter discharge, Emission uniformity (EU_f), uniformity coefficient (U_s), Coefficient of manufacture's variation (C_v), Emitter flow variation (Q_{avg}), Application efficiency and Distribution efficiencywere recorded and are presented in the form of tables.

Observation of Discharge of Drip Irrigation System

Discharge are recorded in different pressure are 0.8 kg cm^{-2} and 1.0 kg cm^{-2} are presented in Table 1.

Table 1: Average emitters flow rate (l h^{-1}) under different operating pressure

S. No.	1	2
Emitter (l h^{-1})	1.3	1.3
Operating pressure (kg cm^{-2})	0.8	1.0
Avg. Discharge of drip (l h^{-1})	1.0	1.1

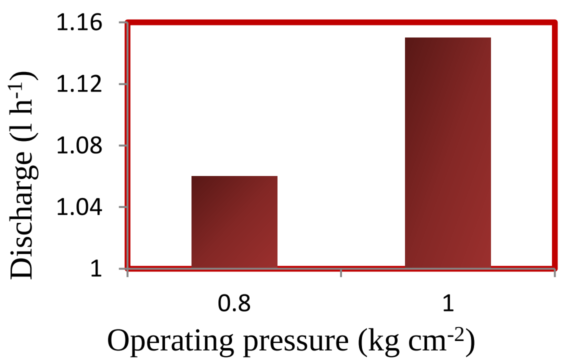

Fig. 1: Discharge variation under different operating pressure

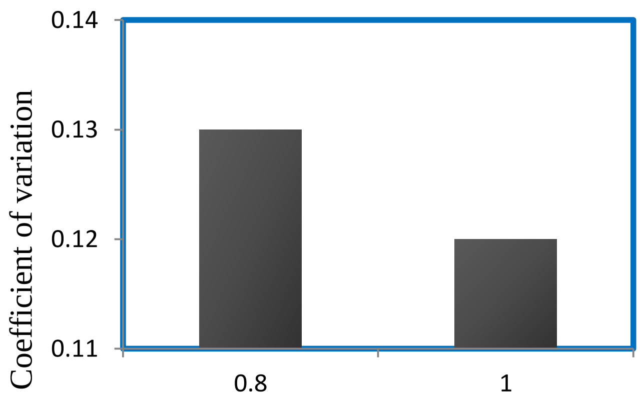

Fig. 2: Coefficient of variation under different operating pressure

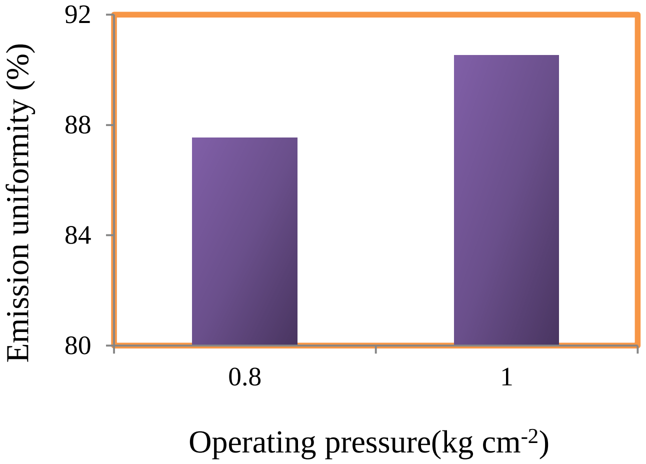

Fig. 3: Emission uniformity under different operating pressure

Drip irrigation discharges were measured at different pressures. The discharge rate increased as the pressure increases. At pressure of 0.8 kg cm^{-2}, the discharge 1.3 l h^{-1} drippers were found to be 1.06 l h^{-1} respectively and at pressure of 1.0 kg cm^{-2}, the discharge 1.3 l h^{-1} drippers were found to be 1.15 l h^{-1} respectively.

Coefficient of variation (C_v)

Coefficient of variation of 1.3l h^{-1} emitter at different operating pressure are0.8 kg cm^{-2} and 1.0 kg cm^{-2} are presented in Table 2.

Table 2: Coefficient of variation under different operating pressure

S. No.	1	2
Emitter (l h^{-1})	1.3	1.3
Operating pressure (kg cm^{-2})	0.8	1.0
Coefficient of variation	0.13	0.12
Classification	Good	Good

The coefficient of variation 0.13 for 1.3 l h^{-1} dripper was found at 0.8 kg cm^{-2} operating pressure and 0.12 at 1.0 kg cm^{-2} operating pressure. Thus for a particular spacing, coefficient of variation decreases as the operating pressure is increased for all emission devices. From the table it is evident that when the operating pressure of drip system is decreased, coefficient of variation increases means the pressure directly affected the discharge rate of emitter.

Emission uniformity (EU_f)

The calculated emission uniformity data at different pressure are 0.8 kg cm $^{-2}$ and 1.0 kg cm $^{-2}$are presented in table 3.

Table 3: Emission uniformity under different operating pressure

S. No.	1	2
Emitter (l h^{-1})	1.3	1.3
Operating pressure(kg cm^{-2})	0.8	1.0
Emission uniformity (%)	87.53	90.54
Classification	Good	Excellent

The average emission uniformity coefficient observed at 0.8 kg cm $^{-2}$ operating pressure was 87.53 %for 1.3 l h^{-1} respectively (Table 3). The average emission uniformity coefficient observed at 1.0 kg cm^{-2} operating pressure was 90.54 %for 1.3 l h^{-1} respectively. It is clear from the table that emission uniformity at 1.2 kg cm^{-2} operating pressure is best.

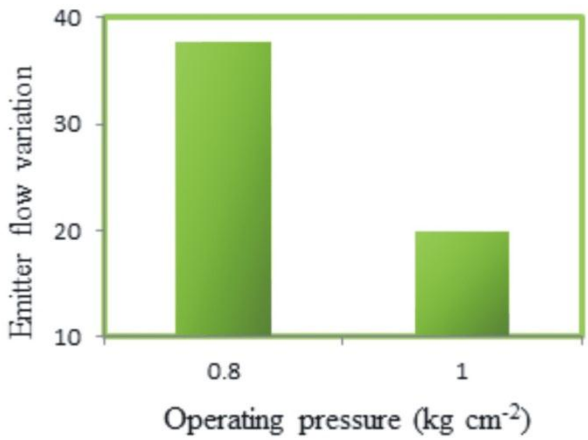

Fig. 4: Emitter flow variation under different operating pressure

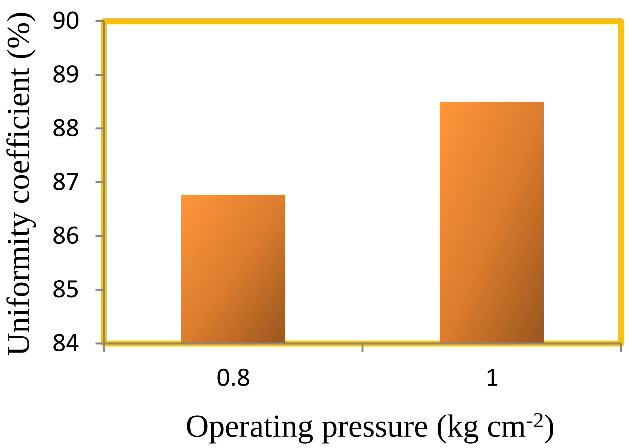

Fig. 5: Uniformity coefficient under different operating pressure

Emitter flow variation (Q_{var})

The calculated emitter flow variation data at different pressure are 0.8 kg cm $^{-2}$ and 1.0 kg cm^{-2} are presented in table 4.

Table 4: Emitter flow variation under different operating pressure

S. No.	1	2
Emitter	1.3	1.3
Operating pressure(kg cm^{-2})	0.8	1.0
Emitter flow variation (%)	37.70	20.0
Classification	Not acceptable	Acceptable

The emitter flow variation 37.70% was found at 0.8kg cm^{-2}operating pressure and emitter flow variation 20% was found at 1.0 kg cm^{-2}operating pressure.From the observed data it is clear that the emitter flow variation mostly depends on the performance of emitter under the field condition, if the ratio between minimum and maximum discharge value is more then it will give low emitter flow variation which will come under desirable range.

Uniformity coefficient (Us)

Uniformity coefficient of 1.3 l h^{-1} emitter at different operating pressures 0.8kg $cm^{-}$and 1.0 kg cm^{-2}, respectively, has been presented in Table 5.

Table 5: Uniformity coefficient under different operating pressure

S. No	1	2
Emitter (l h^{-1})	1.3	1.3
Operating pressure (kg cm^{-2})	0.8	1.0
Uniformity coefficient (%)	86.75	88.48
Classification	Very good	Very good

The average uniformity coefficient 86.75% was observed at operating pressure 0.8 kg cm^{-2} and average uniformity coefficient 88.48% was observed at 1.0 kg cm^{-2} operating pressure. It is clear from the table that emission uniformity at 1.0 kg cm^{-2} operating pressure is best.

CONCLUSION

As per the results of different parameters like average emitter discharge, emission uniformity (EU_f), uniformity coefficient (U_s), coefficient of manufacture's variation (C_v) and emitter flow variation (Q_{avg}) the good performance of drip irrigation system was found at 1.0 kg cm^{-2} operating pressure.

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