International Journal of Applied Engineering and Technology ISSN: 2277-212X (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jet.htm
2015 Vol. 5 (2) April-June, pp.58-63/Manisha et al.
Research Article

STUDIES ON HYDRAULIC PERFORMANCE OF DRIP IRRIGATION SYSTEM UNDER DIFFERENT OPERATING PRESSURE

Manisha, *Jitendra Sinha and Tripathi M.P.
SV College of Agricultural Engineering and Technology and Research Station, IGKV, Raipur-492006, Chhattisgarh, India
**Author for Correspondence*

ABSTRACT

Drip irrigation 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. Hydraulic design seems to be only one of the minor factors in the evaluation of overall uniformity of a micro-irrigation system. A field experiment was conducted at Faculty of Agricultural Engineering, IGKV, Raipur to analyze the hydraulic performance drip irrigation system on emitter discharge, coefficient of variation and emission uniformity. The objective of this study were to collect discharge rate at four different pressure are 1.5, 1.2, 0.9 and 0.7 kg /cm^2 to assess the hydraulic performance of drip irrigation system. 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). The extent to which manufacturer is able to control variations depends not only upon manufacturing and materials quality control but also on emitter design. Emission uniformity of the system decides the uniformity distribution of discharge by each emitter or uniformity distribution of water to each crop. 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. The average emission uniformity coefficient observed at 1.5, 1.2, 0.9 and 0.7 kg /cm^2 pressure was 95.04, 95.95, 94.44 and 87.63 percent respectively for 4lph. It is clear from that emission uniformity at 1.2 kg /cm^2 operating pressure.

Keywords: *Drip Irrigation, Discharge Rate, Coefficient of Variation, Emission Uniformity*

INTRODUCTION

Water in these regions is the most limiting factor requiring its optimal use. Irrigation water is supplied to the plants/crops to replenish root-zone moisture storage when natural rainfall is inadequate or poorly distributed. The efficient utilization of irrigation water is possible by the adoption of high efficient irrigation system, such as, drip irrigation systems. 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. Drip irrigation system can apply frequent and small amounts of irrigation water at many points of a field surface/subsurface near the plants (Decroix and Malaval, 1985; Youngs *et al*., 1999). With drip irrigation, plant water and fertilizer requirements can also be applied to the plant root zone with minimum losses, maintaining steady moisture in the soil profile. In addition, drip irrigation system has the advantage of fitting to difficult topography (Wei *et al*., 2003).

Drip irrigation has advantages of less hindrance with cultural operations and improved cultural practices, allows field operations even during irrigation, 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.

Drip irrigation is arguably the most efficient method of providing water to trees, crops, gardens and landscapes. The efficiency of a well-designed drip irrigation system can reach nearly 100 percent. Drip irrigation can potentially provide high application efficiency and achieve high application uniformity. Both are important in producing uniformly high crop yields and preserving water quality, when both water and chemicals are applied through the irrigation system. The hydraulic and topographic situation of

Research Article

the system causes variation in pressure heads at each outlet. Therefore, it is necessary to study the effect of variable operating pressure on emitter discharge at individual outlets. As the pressure variation increases, the uniformity and application efficiency of the system is reduced (Solomon, 1984) which increases the water losses. Evaluation of hydraulics of drip irrigation system helps in improving the design of irrigation system and better control of irrigation water. Cherry tomatoes are small tomatoes that range from the size of a dime to the size of a half-dollar piece. These small tomatoes often have a sweeter taste than full-size tomatoes and offer several nutritional benefits. A serving of five cherry tomatoes contains 20 calories, the majority of which comes from carbohydrates – 80 percent. Twenty percent of the calories in a serving come from protein, and none comes from fat as cherry tomatoes do not have any fat. While a serving of cherry tomatoes is a low-calorie snack, between-meal snacks should contain 100 to 200 calories, according to The Diet Channel. Cherry tomatoes provide 4 g of carbohydrates per serving. The carbohydrates in cherry tomatoes help meet your energy needs. The Institute of Medicine suggests consuming 130g of crabs each day.

MATERIALS AND METHODS

Experimental Site

Field experiments were carried out during the year 2014-15 at Faculty of Agricultural Engineering, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.), located in the central part of Chhattisgarh at Longitude 81.360 E, Latitude 21.160 N and at an Altitude of 289.56 meters above the mean sea level.

Experimental Design and Treatments

The experiments were laid out in a Split Plot Design (SPD) having three replications (Figure 1). In this experiment, the main plot treatment at different levels of irrigation and sub plot treatment at different type of mulches (black plastic mulch, paddy straw and without mulch) were utilized. Cherry tomato was planted utilizing four levels of irrigation, in which three level of irrigation were provided by drip system (60% of CWR, 80% of CWR and 100% of CWR) and fourth level of irrigation was provided by furrow irrigation. Both the treatment was randomized to check the effect of different irrigation levels and different type of mulches. Drip irrigation system consists of drip tubing placed in each row of plant. During the treatment, irrigation levels were maintained by use of control valve in each row. During irrigation, water pressure in the system was maintained at 1.2 kg/cm2. The cherry tomato plants were spaced at 1m x 1m and the black polythene mulch and straw mulches applied during the study period.

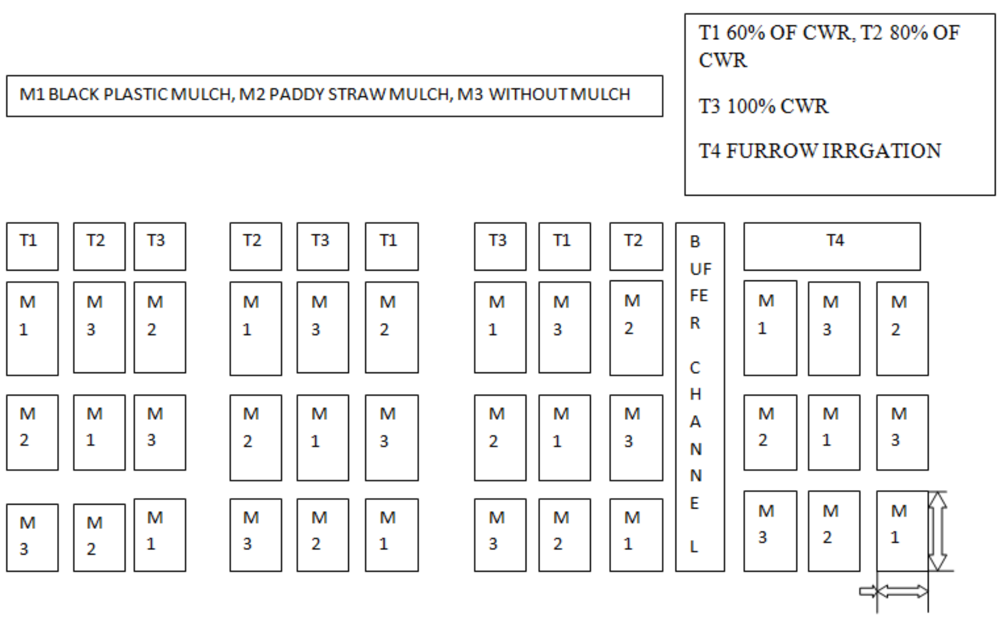

Figure 1: Layout of experimental field

Research Article

Measurement of Discharge from Emitters

Emitters having discharge capacity i.e.1.3 and 2.4 lph respectively were tested at different operating pressure i.e. 1.5, 1.2, 0.9 and 0.7 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 bore well, filtered through an inline, 100 mesh screen. 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 (C_v) is a statistical parameter expressed as

$$C_V = \frac{S}{q_a}$$

Where, s is standard deviation of flow and q_{avg} is the mean flow for a sampled number 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 (C_v). Common causes of manufacturing variation are the inability to hold the dimensional tolerance due to the molding pressure and temperature variation in the material used. The extent to which manufacturer is able to control variations depends not only upon manufacturing and materials quality control but also on emitter design. The manufacturing coefficient of variation is determined from the flow rate measurement for several identical devices and is computed with following equation:

$$C_v = \frac{(q_1^2+q_2^2+q_3^2+q_4^2+q_n^2-nq_a^2)^{\frac{1}{2}}}{q_{a\,(n-1)^{\frac{1}{2}}}}$$

Where, C_V = coefficient of manufacture's variation
q_1, q_2, q_3, q_n = are the discharges (l/h)
n = number of emission devices tested
S = standard deviation
qa = average discharge of emitter

Emission Uniformity (EU)

Emission uniformity is the measure of the uniformity of emitters discharge from all the emitters of drip irrigation system and is the single most important parameter for evaluating system performance. EU shows relationship between minimum and average emitter discharge. It depends upon water temperature and manufacturer's coefficient of variation of the system..Based on it the following equation is commonly used to estimate the design emission uniformity in point source and line source drip irrigation system.

$$EU_f = \frac{q_m}{q_a} \times 100$$

Where, EU_f = the field test emission uniformity, percentage
q_m = is the minimum discharge rate computed from the minimum pressure in the system
q_a = average of all the field data emitter discharge, l/h

RESULTS AND DISCUSSION

Evaluate the hydraulic performance under the discharge of drip irrigation with different discharge, coefficient of variation and uniformity coefficient were recorded and are presented in the form of tables.

Observation of Discharge of Drip Irrigation System

Discharge are recorded in different pressure are1.5 kg/cm^2, 1.2 kg/cm^2, 0.9 kg/cm^2, and 0.7 kg/ and are presented in Table 1.

Research Article

Table 1: Average emitters flow rate (l/h) under different operating pressure

Sr. No	Emitter	Average emitter flow rate (l/h) 1.5 (kg/cm^2)	1.2 (kg/cm^2)	0.9 (kg/cm^2)	0.7 (kg/cm^2)
1.	4 lph	3.978	3.813	3.56	2.75

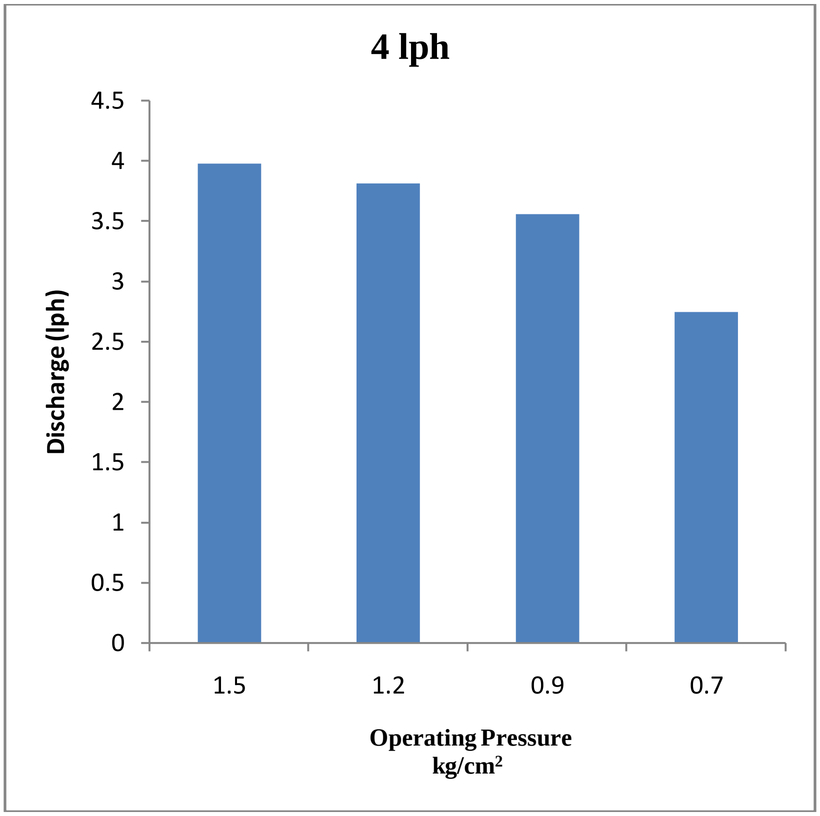

Figure 2: Discharge variation for 4 lph dripper under different operating pressure

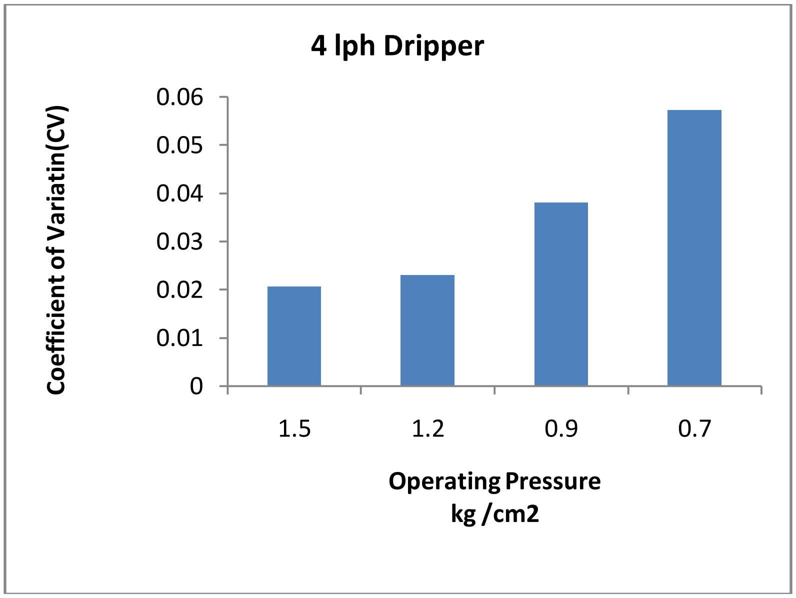

Figure 3: Coefficient of variation for 4 lph dripper under different operating pressure

Research Article

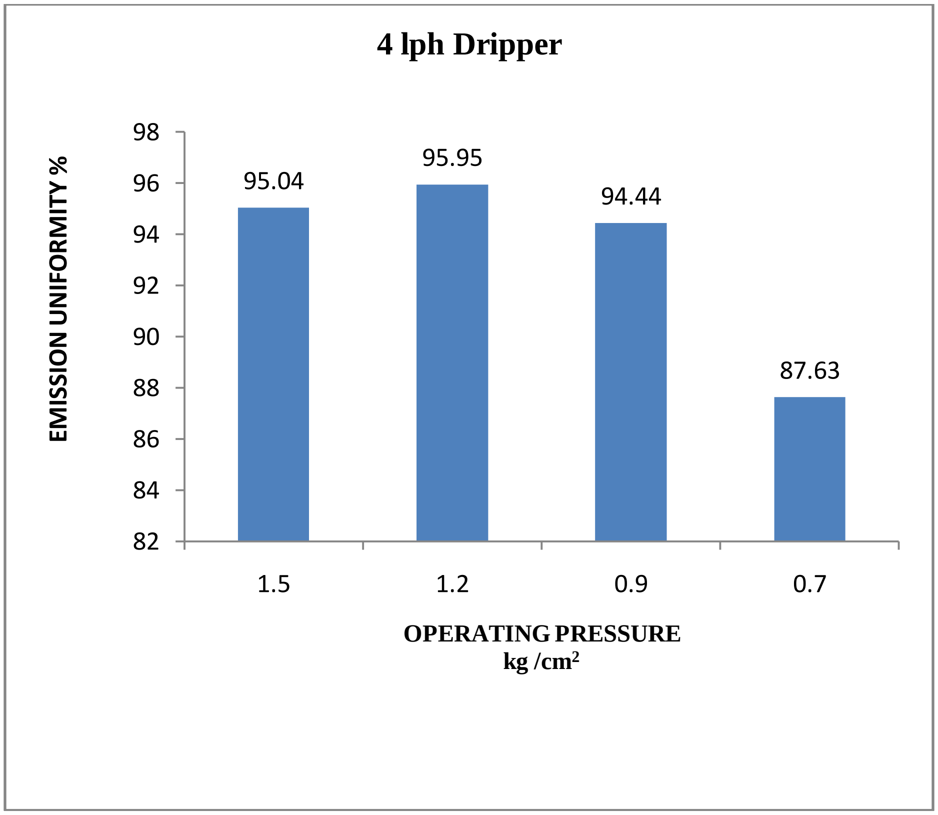

Figure 4: Emission uniformity for 4 lph dripper under different operating pressure

Drip irrigation discharges were measured at different pressures. The discharge rate increased as the pressure increases from 0.70 to 1.5 kg/cm^2. At maximum pressure of 1.5 kg/cm^2, the discharge 4 lph drippers were found to be 3.978 lph respectively. When pressure decreased from 1.5 to 1.2 kg/cm^2, the discharge rate came down to3.813lph respectively. When pressure decreased from 1.2 to 0.9 kg/cm^2, the discharge rate came down to3.56 lph, respectively. When pressure decreased from 0.9 to 0.7 kg/cm^2, the discharge rate came down to2.75 lph. From the table it is evident that when the pressure is reduced then the discharge also reduces.

Coefficient of Variation (C_v)

Coefficient of variation of 4lph emitter at different operating pressure are1.5 kg/cm^2, 1.2 kg/cm^2, 0.9 kg/cm^2, and 0.7 kg/cm^2 and are presented in Table 2

Table 2: Coefficient of variation under different operating pressure

		Average emitter flow rate (l/h)			
S NO.	**Emitter**	**1.5 (kg/cm^2)**	**1.2 (kg/cm^2)**	**0.9 (kg/cm^2)**	**0.7 (kg/cm^2)**
	4 lph	0.0206	0.0230	0.0380	0.0573
1.	Classification	Good	Good	Good	Average

The coefficient of variation 0.0573 for 4 lph dripper was found maximum at 0.7 kg/cm² operating pressure and minimum 0.0206 at 1.5 kg/cm² 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)

The calculated emission uniformity data at different pressure are 1.5 kg/cm^2, 1.2 kg/cm^2, 0.9 kg/cm^2, and 0.7 kg/cm^2 and are presented in table 3.

Table 3: Emission uniformity under different operating pressure

Operating pressure	**1.5 kg/cm^2**	**1.2 kg/cm^2**	**0.9 kg/cm^2**	**0.7 kg/cm^2**
Emission uniformity, (%) (4lph)	95.04	95.95	94.44	87.62
Classification	Excellent	Excellent	Excellent	Good

The Drip irrigation system was operated at 0.7, 0.9, 1.2 and 1.5 kg/cm^2 operating pressures for 4 lph dripper discharge. The average emission uniformity coefficient observed at 1.5 kg/cm^2 operating pressure was 95.04 for 4 lph respectively (Table 3). The average emission uniformity coefficient observed at 1.2 kg/cm^2 operating pressure was 95.95 percent for 4 lph respectively. The average emission uniformity coefficient observed at 0.9 kg/cm^2 operating pressure was 94.44. percent for 4 lph respectively. The average emission uniformity coefficient observed at 0.7 kg/cm^2 operating pressure was 87.63 percent for 4 lph respectively. It is clear from the table that emission uniformity at 1.2 kg/cm^2 operating pressure is best.

Conclusion

Study of hydraulic performance of drip irrigation system will be helpful for deciding Operating pressure, lateral, emitter and plant spacing along with duration of irrigation through an emitter of known discharge.

REFERENCES

Deshmukh YK (2012). *Hydraulic Performance and Economic Analysis of Drip Irrigation System for Bottle Gourd Crop*. M. Tech. Thesis.

Hezarjarbi A, Dehghani AA, Meftah Helghi M and Kiani A (2008). Hydraulic Performance of Various Trickle Irrigation Emitters. *Journal of Agronomy* **7** 265-271.

Kirnak H, Dogan E, Demir S and Yalcin S (2004). Determination of Hydraulic Performance of Trickle Irrigation Emitters used in Irrigation Systems in the Harran Plain. *Turkish Journal of Agriculture and Forestry* **28** 223-230.

Kirnak H, Dogan E, Demir S and Yalcin S (2004). Determination of Hydraulic Performance of Trickle Irrigation Emitters used in Irrigation Systems in the Harran Plain. *Turkish Journal of Agriculture and Forestry* **28** 223-230.

Kumar S and Singh P (2007). Evaluation of Hydraulic performance of Drip Irrigation System. *Journal of Agricultural Engineering* **44**(2).

Mohammed A Almajeed A Alabas (2013). Evaluation the Hydraulic Performance of Drip Irrigation System with Multi Cases. *The Global Journal of Researches in Engineering* **13**(2-J).

Popale PG, Bombale VT and Magar AP (2011). Hydraulic Performance of Drip Irrigation System. *Engineering and Technology in India* **2**(1&2) 24-28.

Safi B, Neyshabouri MR, Nuzemi AH, Massina S and Mirlatifi SM (2007). Water Application Uniformity of a Sub Surface Drip Irrigation System at Various Operating Pressure and Tape Lengths. *Turkish Journal of Agriculture and Forestry* **31** 275-285.

Sahu RK and Rao VN (2005). Faculty of Agricultural Engineering IGKV Raipur. *Journal of Drainage and Irrigation Water Management* 118-135.

Sharma U (2010). *Hydraulic Performance and Energy use of Drip Irrigation System for Capsicum (Capsocum Annuum) Crop*. M. Tech. Thesis.

Tagar AA, Mirjat MS, Soomro A and Sarki A (2010). Hydraulic Performance of Different Emitters under Varying Lateral Lengths. *Pakistan Journal of Agriculture, Agricultural Engineering and Veterinary Science* **26**(2) 48-59.