



A field study on hydraulic performance of drip irrigation system for optimization of operating pressure

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Abstract: Drip irrigation technology will undoubtedly play an important role in the future of agriculture. A field experiment was conducted to evaluate the performance of drip system with five operating pressures viz. I_1 (0.4 kg/cm²), I_2 (0.6 kg/cm²), I_3 (0.8 kg/cm²), I_4 (1.0 kg/cm²), I_5 (1.2 kg/cm²). It was observed that the average discharge of drippers was 1.08 lph, 1.24 lph, 1.50 lph, 1.62 lph and 1.74 lph and emission uniformity was 80.55%, 84.89%, 86.30%, 88.88% and 90.80% in each treatment respectively and coefficient of variation was observed 0.12, 0.13, 0.12, 0.11, and 0.09. Flow component was found 0.450 and the value of k was 0.572 while R^2 was observed 0.986. Based on the result it can be concluded that the operation of drip irrigation system at 1.2 kg/cm² pressure head, gives the maximum efficiency in respect of discharge, emission uniformity and coefficient of variation.

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

INTRODUCTION

Micro irrigation is frequent application of water directly on or below the soil surface near the root zone of plants. The hydraulic performance of drip irrigation system is indicated by water distribution uniformity, which is measured by uniformity coefficient (BIS, 1991; Wu and Giltin, 1983), emission uniformity (BIS, 1991), coefficient of variation (BIS, 1991; Wu, 1997) and coefficient of manufacturing variation (Wu and Giltin, 1983). The uniformity coefficient and emission uniformity increased while coefficient of variation decreased as the operating pressure head increased for all emission devices (Kumar and Singh, 2007). The different measures for hydraulic performance of drip irrigation system are very useful for effective design and operation of the system. Gil *et al.* (2002). The pressure discharge relationship follows a power function Sharma *et al.* (2005). The coefficient of uniformity (CU) and the distribution uniformity (DU) generally increase with increasing heads and decrease with increasing slope. The CU generally followed a linear relationship with either head or slope Ella *et al.* (2009). Well designed drip irrigation will lose practically no water to runoff, deep percolation or evaporation. The present study was conducted on drip irrigation system to develop a pressure discharge relationship, and to estimate the emission uniformity, coefficient of variation at different operating pressure.

MATERIALS AND METHODS

Location and soil of experimental site The field investigation was conducted at Water Management plot of

South Pangabri upland adjoining to Rajendra Agricultural University farm in October, 2012. Pusa is situated on the bank of the *Budhi Gandak* River. It lies at 25.980 N latitude, 85.670 S longitudes and at an altitude of 52.00 meter above the mean sea level. The field has an approximate uniform topography with deep and well drained sandy loam soil. The soil consists of 25.29 percent sand, 48.53 per cent silt and 26.18 per cent clay. An existing shallow tube well available near the site was used as the source of irrigation water. The diameter of the tube well was 8 inch and a submersible pump was used for water lifting. A foot valve with strainer was provided on the suction side to prevent the inflow of trash, impurities and suspended sand particles. On the delivery side, arrangement for priming and regulating pressure a bypass was provided. The delivery pipe was connected with gate valves, pressure gauge and screen filter. The laterals from sub main were connected by gromate take off. Inline laterals (16 mm LLDPE, 2.6 kg/cm²) pipes of emitters spacing 30 cm were laid over the ground surface at a spacing of 50 cm. The laterals were connected to sub main. Emitters were non pressure compensating having discharge of 2.4 lph.

Emitter discharge measurement by volumetric method: After removing the entrapped air from the different components of the system like main, sub main and laterals through flush valve and attending the stable flow condition at a desired operating pressure, the observation were taken. The discharge was collected in catch can for a duration of 5 minute of various operating pressures viz. 0.4, 0.6, 0.8, 1.0, 1.2 kg/cm²

and was measured by a measuring flask. The various emitter locations were selected randomly and thus the observation were taken for the 8 emitters at head, middle, tail. Three laterals were selected for the observation in each treatment.

Emission uniformity: The EU (emission uniformity) during the field test is the ratio expressed as a percentage of the average emitter discharge from the lowest 1/4th of the emitter to the discharge of all the emitters for minimum discharge, as recommended by the United State Soil Conservation Service for field evaluation of irrigation system and is expressed by the equation.

$$EU = \frac{q_n}{q_a} \times 100$$

Where; EUf = the field test uniformity, percent, q_n = average of the lowest 1/4th of the field data emitter discharge, lph

Pressure-discharge relationship: Pressure discharge relationship was established by using the equation given by Keller (1974). Which is given below:

$$q = K x H^x$$

Where, q = Average flow rate through the emitter, K = Multiplying constant specific to the emitter, H = Initial pressure head of lateral, x = Flow component, whose value depends on the flow regime.

Coefficient of manufacturer's variation 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 and is computed with the formula given by Keller and Karmeli (1974).

$$Cv = \frac{s}{qa}$$

Where, Cv= coefficient of manufacturer variation S= standard deviation qa= Average emitter discharge

RESULTS AND DISCUSSION

Performance evaluation of the system: The maximum mean emitter discharge (1.74 lph) was found at 1.2 kg/cm² and minimum mean emitter discharge (1.05 lph) was found at 0.4 kg/cm². It is clear that emitter discharge increase exponentially with increase in pressure head. It was found that the uniformity coefficient varied from 80.55 per-cents to 90.80 per cent. The maximum uniformity coefficient (90.80%) was found at pressure 1.2 kg/cm². It was found that the coefficient of manufacturing variation varies from 0.09 to 0.13. The maximum coefficient of variation (0.13) was found in treatment I₂ and minimum (0.09) was found in treatment I₅ the uniformity coefficient and emission uniformity increased while coefficient of variation decreased as the operating pressure head increased for all emission devices. The same result of uniformity coefficient, emission uniformity and coefficient of variation was found as in evaluation of hydraulic performance of drip irrigation system by (Kumar and

Table 1. Table Average discharge (lph) uniformity coefficient EU (%) and coefficient of discharge (Cv) at different operating pressure (kg/cm²).

Treatment	Discharge (lph)	Cv	EU (%)
I ₁	1.08	0.12	80.55
I ₂	1.24	0.13	84.89
I ₃	1.46	0.12	86.30
I ₄	1.62	0.11	88.88
I ₅	1.74	0.09	90.80

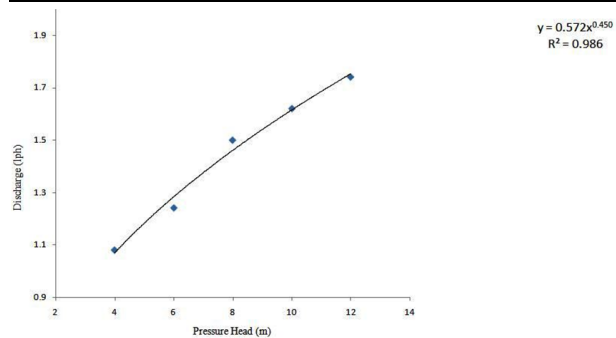


Fig. 1. Pressure discharge relationship at different operation pressures.

Singh, 2007). The uniformity coefficient and emission uniformity increased while coefficient of variation decreased as operating pressure increased for all emission devices (Popale *et al.*, 2011). The low CV indicated good performance of the system throughout the cropping season. CV estimated by Decroix and Malaval (1985) and Bargel *et al.* (1996) for the in-line labyrinth type drippers was reported to be 0.066. Bargel *et al.* (1996) had concluded that a CV between 0.05 and 0.066 indicated a good performance of the drip system.

Pressure discharge relationship: It is clear that emitter discharge increase exponentially with increase in pressure head. The maximum mean emitter discharge (1.74 lph) was found at 1.2 kg/cm² and minimum mean emitter discharge (1.05 lph) was found at 0.4 kg/cm² the value of k and x were found to be 0.572 and 0.450 respectively by the regression of pressure head and mean emitter discharge.

The mean emitter flow for each treatment was observed and the whole plot was determined and a relationship between emitters discharge was established as shown in fig.1 which is statistics the standard relationship. The CU generally followed a linear relationship with either head or slope Ella *et al.* (2009).

Conclusion

From the results this could be concluded that, the best performance of the system was obtained under drip irrigation with 1.2 kg/cm² operating pressure. It gives highest values of discharge, uniformity coefficient, and coefficient of manufacturing variation.

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