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RESEARCH ARTICLE :

Comparative analysis of drippers

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SUMMARY : Drip or trickle irrigation is the method of irrigation which is becoming increasingly popular in areas with water scarcity and salt. An experiment was conducted to evaluate hydraulic performance of new drippers and to evaluate hydraulic performance of used drippers of different ages at Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jabalpur. The study was conducted to evaluate the hydraulic performance of drip irrigation system with new drippers of size 2lph, 4 lph and 8 lph. The different hydraulic measures *viz.*, uniformity co-efficient, emission uniformity, co-efficient of variation and head discharge relationship at different operating pressure were determined by measuring discharge of different emission devices. The discharge of dripper have been measured along the lateral with dripper spacing of 1 m at five operating pressure (60 Kpa, 80 Kpa, 100 Kpa, 120 Kpa and 140 Kpa). The variation in discharge of 2 lph size dripper (for four replications) with 60 Kpa, 80 Kpa, 100 Kpa, 120 Kpa and 140 Kpa operating pressure has been depicted. The Uniformity co-efficient (Cu) has been computed using Christiansen's equation. Replication wise Cu values have been presented for 2lph, 4 lph and 8 lph size new drippers. The maximum and best value of Cu is 98.38, 97.26 and 99.37 per cent at 2, 4 and 8 lph (new dripper) sizes at operating pressure of 100, 140 and 100 Kpa, respectively. The Cv value for three size of dripper as obtained during study. It has been observed from tables, that the average of Cv for different dripper size and at various operating pressure is in the range from 0.01 to 0.06. Emission uniformity is typically used to evaluate manufacturing quality of the drippers and it was calculated using the equation. The results show that all the drippers performed better at the pressure range of 60 to 140 Kpa, with the emission uniformity of 80.34 to 97.82 per cent. In this study, a relationship between flow rate and pressure head has been developed for 2 lph, 4 lph and 8 lph drippers. The discharge equations obtained are Q= 1.4564x0.078, (For dripper size 2 lph), Q= 4.651x0.023, (For dripper size 4 lph), Q= 6.001x 0.3456 (For dripper size 8 lph).

KEY WORDS :
Drip irrigation, Uniformity co-efficient, Emission uniformity, Co-efficient of variation, Discharge, pressure

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BACKGROUND AND OBJECTIVES

Drip or trickle irrigation is the method of irrigation which is becoming increasingly popular in areas with water scarcity and salt problems. It is a method of watering plants frequent and slow application of water to the soil near the root zone of the plant, thereby minimizing conventional losses such as deep percolation, runoff and soil water evaporation. The following characteristics in drip, makes it efficient for irrigation to crops are low rates, over long periods of time, at frequent intervals, near or directly into the root zone, at low pressure, usually maintain relatively high water content, used on higher value agricultural/horticultural crops and in landscapes and nurseries, very high water application efficiency (90-95%) can be obtained through drip irrigation method.

The estimation of pressure loss along the length of a drip line has been derived in a form of simple differential equation by Wu and Gitlin (1974), while Keller and Karmeli (1974, 1975 and 1990) devised an equation that was of the power form for the emitter characteristics. Dhakad (1997) evaluated the hydraulic performance of commercially available emitters under varying pressure at first stages. The second part of the study was to see the wetting pattern of different emitters under laboratory condition. It was found that emitters discharge decreases when pressure is reduced from 1.1 to 0.8 kg/cm². The reduction of discharge is maximum in NPC, while in PC emitter, there is practically no reduction.

Christiansen (1942) proposed a co-efficient of uniformity (CU) for evaluating the uniformity of water application, particularly in sprinkler irrigation system. This is based on the sum of the absolute deviations of each observed value of discharge from their mean value as follows:

$$CU = [1 - \{X / (m\ n)\}]\ 100$$

where,

X = Absolute numerical deviation of individual observations from the average discharge rate, lph.

m = Average value of all observed values of discharge rate, Lph.

n = Total number of observations.

Karmeli and Keller (1974) suggested the following equation for determining the uniformity co-efficient based on the co-efficient of manufacturing variation and the minimum and average discharge rates of drippers:

$$EU = 100\ (1 - 1.27\ CV_E)\ qn/\ qa$$

where,

EU = Emission uniformity.

CV_E = Effective co-efficient of manufacturing variation= CVm / n

CVm= Co-efficient of manufacturing variation

n = Number of dripper per plant.

Perea *et al*. (2013), analyzes the statistical relationship between manufacturing and hydraulic variations of low-pressure operating emitters assuming that both are independent random variables. Gilbert *et al*. (1981) studied emitter clogging and other flow problems of trickle irrigation. The research conducted to develop water treatment methods for preventing emitter clogging and maintaining long-term operation of the system under actual field conditions.

RESOURCES AND METHODS

Experimental area and climate :

A field experiment was conducted at College of Agricultural Engineering, Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jabalpur (M.P). Jabalpur is situated at 23°9' North latitude and 79°58' East longitudes with an altitude of 411.78 meters above the mean sea level. The climate of the locality is characterized as typically sub-tropical and sub-humid, which is featured by hot dry summers and cool dry winters. It comes under "Kymore Plateau and Satpura Hills" agro climate zone of Madhya Pradesh and is broadly known as rice-wheat crop zone. The annual rainfall of Jabalpur region ranges between 1000 to 1500 mm. Various requirements are pump : 5 hp, mainline size : 63 mm (G.I pipe), sub main size : 63mm (PVC pipe),filter : Screen filter, no. of Pressure gauge : 2, lateral size : 30 m, lateral diameter : 10 mm, no. of laterals : 1, no. of drippers : 30, spacing between each emitter : 1m, flow exponent: 0.48, discharge of emitter : 2 lph, 4 lph, 8 lph, types of drippers : Online drippers, beaker : 250 ml, no. of beaker : 30, control valve : Ball valve, operating Pressure : 60, 80,100,120,140 Kpa.

In this study on all factors that can influence the different types and age of drippers under field conditions was undertaken. On pressure compensating drippers most commonly used drippers in the area were selected for study. New, two years used and four years used drippers were obtained from various sources to determine the effect of age on their performance. The emitters with rated flow rates of 2, 4 and 8 lph were selected for the performance tests. The experimental field consisted of one lateral on which 30 emitters spaced at 1 m were placed. Emitter flow rates were measured at the operating pressure range of 60, 80, 100, 120 and 140 Kpa. The pressure was maintained in the laterals by adjusting ball valves located at mainline. The catch cans were placed below the emitter for discharge measurement. The amount of water applied is calculated from emitter flow rates measured at various points in the dripper line. The Cu is a measure of the uniformity of emitter flow rate. As drip irrigation pipe is a collection of point sources in series, there will be differences in application rate and amount in the row space between the emitters. The design operating pressure shall be in accordance with the recommendations of the manufacturers. The system operating pressure must compensate for pressure losses through system components and field elevation effects. According to Keller and Karmeli (1974) and Howell and Hiler (1974) the power law relationship between flow rate and

. . . . **$Q=K_dH^x$**

OBSERVATIONS AND ANALYSIS

The different hydraulic measures *viz.*, uniformity co-efficient, emission uniformity, co-efficient of variation and head discharge relationship at different operating pressure were determined by measuring discharge of different emission devices. The discharge of dripper have been measured along the lateral with dripper spacing of 1 m at five operating pressure (60 Kpa, 80 Kpa, 100 Kpa, 120 Kpa and 140 Kpa). The variation in discharge of 2 lph size dripper (for four replications) with 60 Kpa, 80 Kpa, 100 Kpa, 120 Kpa and 140 Kpa operating pressure has been depicted. The Uniformity co-efficient (Cu) has been computed using Christiansen's equation. Replication wise Cu values have been presented for 2lph, 4 lph and 8 lph size new drippers.The variation in Uniformity co-efficient of 2,4 and 8 lphnew dripper is shown in Table 1, 2 and 3, respetively. The maximum and best value of Cu is 98.38, 97.26 and 99.37 per cent at 2, 4 and 8 lph (new dripper) sizes at operating pressure of 100, 120 and 140 Kpa, respectively. The Cv value for three size of dripper as obtained during study. It has been observed from tables, that the average of Cv for different dripper size and at various operating pressure is in the range from 0.01 to 0.06 and is shown in Fig. 1. Emission uniformity is typically used to evaluate manufacturing quality of the drippers and it was calculated using the equation. The results show that all the drippers performed better at the pressure range of 60 to 140 Kpa, with the emission uniformity of 80.34 to 97.82 per cent. In this study, a relationship between flow rate and pressure head has been developed for 2 lph, 4 lph and 8 lph drippers. The discharge equations obtained are Q= 1.4564x0.078, (For dripper size 2 lph), Q= 4.651 x 0.023, (For dripper size 4 lph), Q= 6.001x0.3456 (For dripper size 8 lph).

Dripper discharge was measured at different operating pressures *i.e.* 2 lph, 4lph and 8 lph and is depicted in Fig. 3, 4 and 5. Dripper discharge was

Table 1 : Variationin uniformity co-efficient of 2l ph new dripper

Pressure, (Kpa)	R^1	R^2	R^3	R^4	Avg.
60	96.63	97.51	97.46	97.05	97.16
80	97.29	98.18	96.29	98.08	97.46
100	98.38	97.86	97.16	97.31	97.88
120	96.65	95.56	95.72	95.56	96.99
140	96.88	98.21	95.56	98.12	97.54

Table 2 : Uniformity co-efficient of 4 lph new dripper

Pressure,(kpa)	R^1	R^2	R^3	R^4	Avg.
60	98.92	98.67	99.27	99.06	98.97
80	99.22	98.30	98.23	98.67	98.72
100	99.28	98.12	98.87	97.26	98.70
120	99.00	99.23	99.31	98.83	99.07
140	99.32	99.22	99.34	99.19	99.26

Table 3 : Uniformity co-efficient of 8 lph new dripper

Pressure,(Kpa)	R^1	R^2	R^3	R^4	Avg.
60	92.08	97.46	97.15	98.01	95.04
80	93.86	95.70	92.11	97.75	94.93
100	96.53	94.20	97.15	98.55	96.37
120	99.37	96.17	95.93	92.68	96.03
140	92.70	95.35	96.26	96.86	94.78

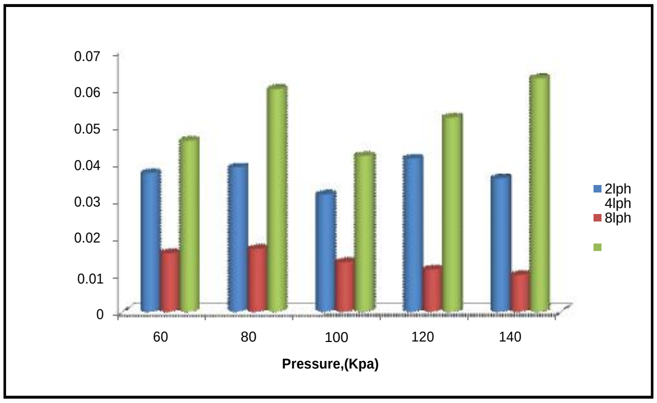

Fig. 1: Co-efficient of variation at different operating pressure

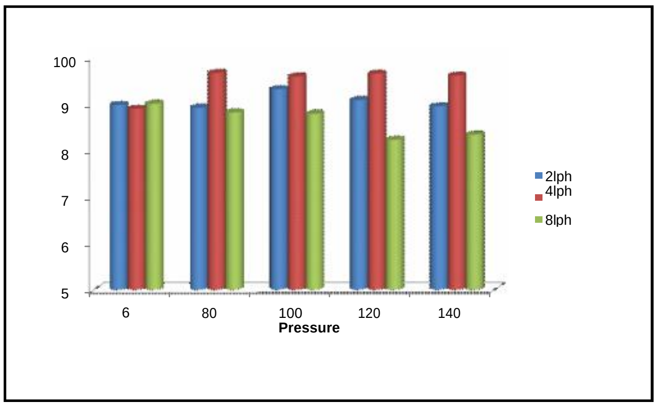

Fig. 2: Average emission uniformity of 2,4 and 8l ph capacity dripper

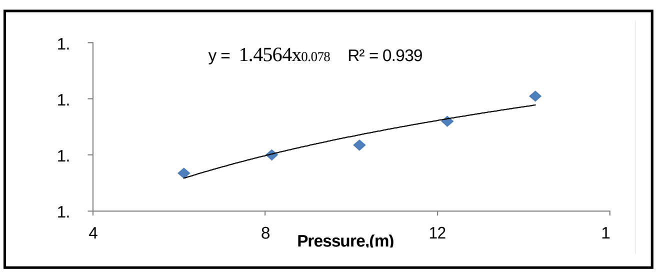

Fig. 3 : Dripper discharge of 2l ph was measured at different operating pressures

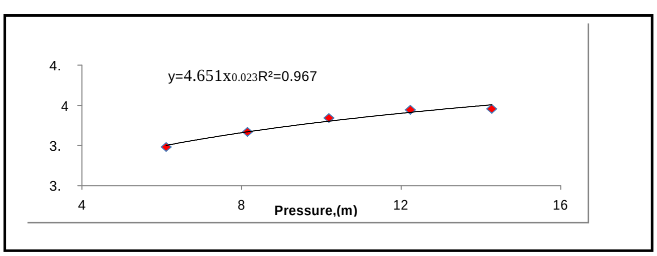

Fig. 4 : Dripper discharge of 4l ph was measured at different operating pressures

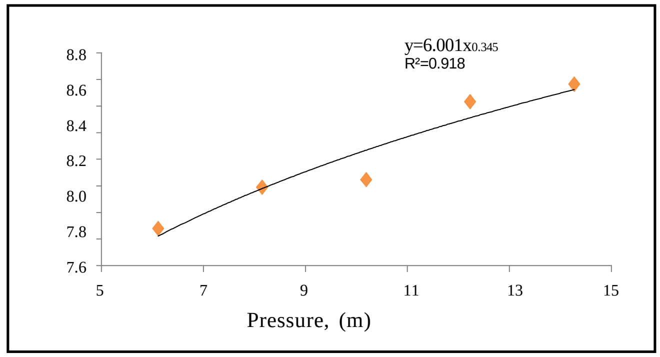

Fig. 5 : Dripper discharge of 8l ph was measured at different operating pressure

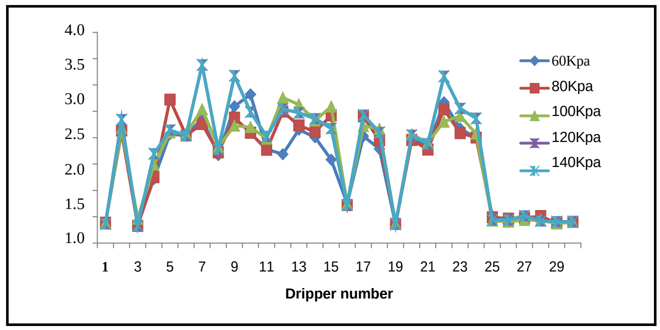

Fig. 6: Discharge of 2l ph (2 years used) drippers at different operating pressure

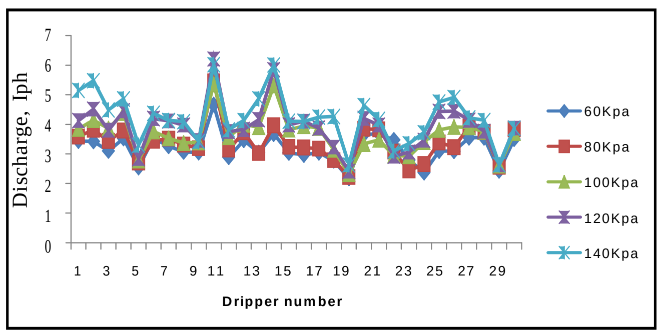

Fig 7 : Discharge of 2l ph (4 years used) drippers at different operating pressure

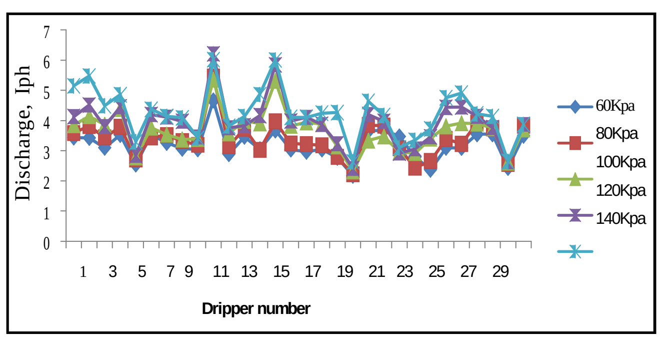

Fig 8 : Discharge of 4l ph (2 years used) drippers at different operating pressure

measured at different operating pressures (4 years used) *i.e.* 2 lph, 4lph and 8 lph and is depicted in Fig. 7, 9 and 11. Dripper discharge was measured at different operating pressures (2 years used) *i.e.* 2 lph, 4lph and 8 lph and is depicted in Fig. 6, 8 and 10. In the study carried out following conclusions can be drawn. Performance of new drippers of 2lph,4lph and 8lph size is excellent class. Performance of 2 years used drippers is very good to fair class and 4 years used drippers is poor to unacceptable class. Drippers should be cleaned and maintained regularly to give better uniformity even after 2 years otherwise replaced after 2 years of use.

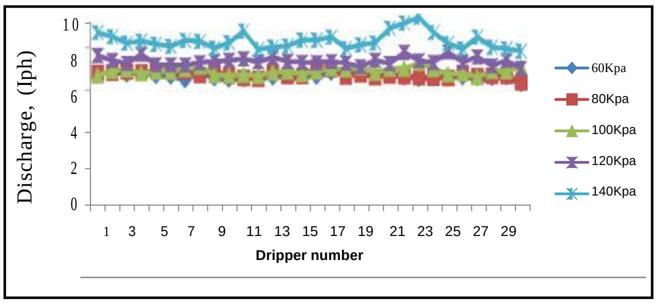

Fig. 9: Discharge of 4l ph (4 years used) drippers at different operating pressure

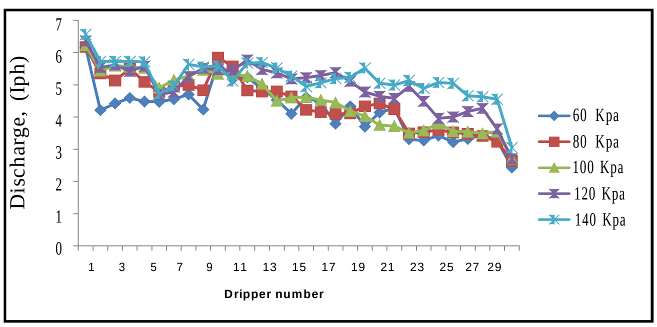

Fig 10 : Discharge of 8l ph (2 years used) drippers at different operating pressure

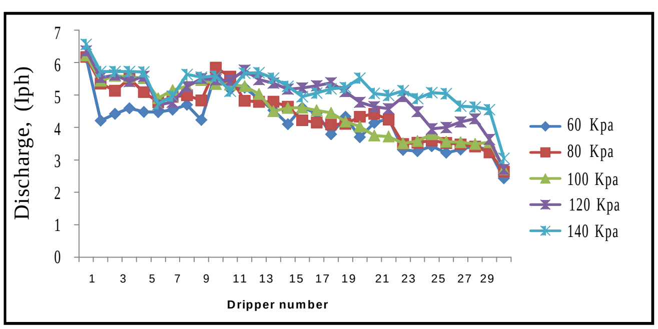

Fig 11 : Discharge of 8l ph (4 years used) drippers at different operating pressure

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