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Research Paper :

Effect of nozzle size and operating pressure on performance of medium volume rain gun

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ABSTRACT

The study was carried out on the Instruction Farm of Irrigation and Drainage Engineering, Dr. Ulhas Patil college of Agricultural Engineering and Technology, Jalgaon during 2009-2010. The medium volume rain gun model was used in the study of the nozzles of 8, 10, 12 and 14 mm diameter size. The empirical equation of the form, $Q= aH^b + C$ fitted for tlfe pressure discharge relationship for the system. The system was operated at various pressures (2, 3, 4 and 5 kg/cm^2) for different nozzle sizes. The increase in nozzle size and operating pressure, increased the discharge of medium volume rain gun. Jet length was also found to be increased in operating pressure. It is observed that increase in pressure increased the discharge of medium volume rain gun system. The minimum discharge was observed at 2 kg/sqcm as 4.17 m^3/hr and 6.47 m^3/hr for 8, 10 mm, respectively. The maximum discharge was observed at 5 kg/sq cm as 7.70 m^3/hr and 10.69 m^3/hr for 8 and 10 mm nozzle size, respectively.

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Key words : Rain gun, Nozzle, Operating pressure, Radius of flow

India, which has 17 per cent of world's population, has roughly 4 per cent of the world's water land area. Geographical area of India is about 329 Mha. The net sown area of the country has almost stabilized at about 143 Mha against the cultivable area 193 Mha of the country. Geographical area of Maharashtra is 30.77 Mha. Out of which 22.36Mha area is under cultivation and only 3.81Mha area is under irrigation. This reveals that only 17.20 per cent of total cultivable area is under irrigation which is far less when compared to average irrigated area at national level (40 %) (Economic survey of Maharashtra 2004-05).

The conventional system of water application revolved around the concept of replenishing the moisture to field capacity only after depletion by 50-60% of available soil moisture. Micro irrigation technologies can provide a reasonable solution to the emerging threats such as scarcity of water, soil salinity, water logging which are basically related to agricultural production. These technologies can improve productivity, raise income through crop yields and output and enhance food security of households. The aim is to increase agricultural production per unit volume of water per unit area of cropped land per unit time. These calls for scientific management of all inputs especially water reasonable for enhance productivity. Irrigation water could be efficiently utilized only by adopting pressurized irrigation methods instead of conventional flood methods. These systems result in overall higher irrigation efficiency as conventional losses such conveyance, percolation, evaporation etc are either totally eliminated or kept at minimum level. These methods are adopted in order to overcome the losses in conventional methods and to use available water efficiently and economically.

In sprinkler irrigation system, rain gun can be used most efficiently for irrigating larger fields in short period with minimum labour requirement. This system consists of a large size nozzle (powerful mega sprinkler) that throws a large amount of water (up to 500 l/min) to a distance up to radius of 90 feet and even more, like a artificial rain. The commonly used hammer action type of the rain gun has some limitations for irrigating.

The research and development on micro irrigation give the proper solution of all problems by launching the medium volume rain gun with jet breaker arrangement and also full circle, half circle and part circle arrangements. Nowadays number of companies are manufacturing rain gun models like, Jain irrigation (model-medium volume

rain gun model 162 and 163), Rain-Bird rain gun (model-SR-3003/F 3002), Italian rain gun (Vedant model-Duplex), Green Gold (model-Pengin), EPe Nashik (model- C.P. Versha). Operating pressure of rain gun vary from 2 to 10 HP high head low discharge type pump is required. Depending up on a model, at a time, a rain gun can irrigate 0.5 to 1 acre area of land within 2 to 3 hrs. This system can save considerable labour, time and electricity besides irrigation water. However, giant sprinklers usually have low water distribution efficiency.

Medium volume rain gun irrigation system is useful for high planting like sugarcane, potato, groundnuts, wheat, vegetables, pulses, oil seeds, cereals, tea, coffee, fodder etc. This system is more popular among the sugarcane farmer due to its effective use in washing out the pests like aphids, white flies etc. and maintain humid climate.

As the medium volume rain gun is recently adopted in India and less information is available on field performance of this advance technology, rain gun irrigation. Hence, proposed study was undertaken to study pressure discharge relationship and to determine radius of flow of medium volume rain-gun for different nozzle sizes under varying operating pressure.

METHODOLOGY

The rain-gun with brand of medium volume rain-gun 162 manufactured by the MIS Jain Irrigation Systems Ltd., Jalgaon was used for the study. Rain-gun of different nozzle sizes ranging from 8, 10, 12 and 14 mm with mechanism of hammer action were used.

Geographically the experimental farm of Dr. Ulhas Patil college of Agricultural Engineering and Technology, Jalgaon is situated in tropical zone (agro climatic zone) at $21^0 03'$ N latitude and $75^0 34'$ E longitudes at an altitudes of 206 m above mean sea level.

The source of water used was the shallow open well located at the comer of the field. The 10 HP pumping unit with bypass arrangement was installed on the well to lift and control the water. Water was supplied to rain-gun through the 63 mm HDPE main line, the aluminium stand with 1.75 m height riser pipe was provided for installation of medium volume rain-gun. On the riser pipe, pressure gauge was provided for measuring the pressure. To regulate the pressure heads at the rain-gun, valve was provided with the bypass arrangement, on the delivery side of the pump. The catch cans were placed at each grid (2x2 m) horizontally. The pressure head was adjusted as per the requirement with the discharge regulating valve.

Pressure discharge relationship of the medium volume rain-gun under the study were studied for the operating pressure of 2, 3, 4 and 5 kg/sqcm. The discharge through the nozzle of different sizes, at different pressures, was collected in the plastic tank of 100 liter capacity. The system was operated for 1 minutes.

RESULTS AND DISCUSSION

The results obtained from the present study have been discussed in the following sub heads :

Pressure discharge relationship:

The observations of pressure discharge relationship given in the Table 1 and depicted in Fig.1 for various nozzle size (8 and 10 mm) show that increase pressure increased the discharge of medium volume rain gun system.

Table 1 : Pressure discharge relationships of medium volume rain gun

Operating pressure (kg/cm^2)	Rain gun discharge, lpm and m^3/hr			
	Nozzle size 8mm		Nozzle size 10mm	
	lpm	m^3/hr	lpm	m^3/hr
2.0	78.63	4.71	112.34	6.74
3.0	98.40	5.90	138.60	8.31
4.0	114.0	6.84	159.00	9.54
5.0	128.4	7.70	178.20	10.69

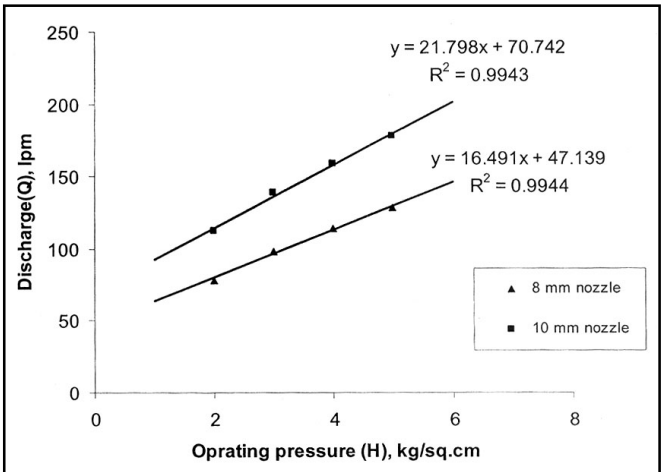

Fig. 1 : Pressure discharge relationships of medium volume rain gun for different nozzle size Pressure and jet length relationship

The observations for pressure and jet length relationship are given in Table 2. Fig 2 shows that increase in pressure increased jet length of the medium volume rain gun. As the pressure increased from 2 to 5 kg/cm^2, the jet length was increased by 31 per cent for 8 mm nozzle size and 36.05 per cent for 10 mm nozzle size of a rain gun. It is seen from the Table 2 that there was more prominent effect of pressure on increase in jet length as

Table 2 : Relationship between jet length and operating pressure at different nozzle size for medium volume rain gun

Operating pressure (kg/cm^2)	Jet length (m) for different nozzle sizes			
	8mm	10mm	12mm	14mm
2.0	19.3	20.8	22.4	23.3
3.0	21.8	23.8	26.0	27.4
4.0	23.9	26.4	28.4	30.0
5.0	25.3	28.3	30.4	32.0

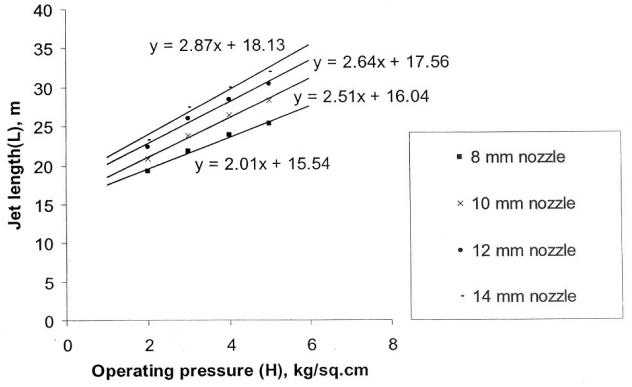

Fig. 2 : Effect of pressure on jet length for different nozzle size for medium volume rain gun

compared to that of nozzle size.

Pressure discharge relationship:

The discharge (Q) of medium volume rain gun was a function of operating pressure (H). The equation, were developed.

$Q = 16.491H + 47.139$, $R^2 = 0.9944$

$Q = 21.798H + 70.742$, $R^2 = 0.9943$

where,

H = Pressure, kg/sq.cm

Q = Discharge, lpm

The discharge of medium volume rain gun increased with increased in pressure and nozzle size.

Pressure and jet length relationship:

The jet length (L) of medium volume rain gun was a function of operating pressure (H).

The equation, were developed

$L = 2.01H + 15.54$, $R^2 = 0.985$

$L = 2.51H + 16.04$, $R^2 = 0.9903$

$L = 2.64H + 17.56$, $R^2 = 0.9811$

$L = 2.87H + 18.13$, $R^2 = 0.973$

where,

H = Pressure, kg/sq.cm

L= Jet length, m

As the pressure increases the jet length also increased during operation of medium volume rain gun.

The discharge of medium volume rain gun increased with the increasing operating pressure and nozzle size. The minimum discharge observed at 2 kg/sq.cm. as 4.17 m^3/hr and 6.47 m^3/hr for 8 and 10 mm, respectively. The maximum discharge was observed at 5 kg/sq cm as 7.70 m^3/hr and 10.69 m^3/hr for 8 and 10 mm nozzle size respectively.

The jet length of medium volume rain gun also increased with the increasing operating pressure and nozzle size. The minimum jet length was observed at 2 kg/sq.cm. as 19.3 m, 20.8 m, 22.4 m, 23.3m for 8,10,12 and 14 mm nozzle size and also the maximum jet length was observed (at 5 kg/sq.cm pressure) as 25.3, 28.3, 30.4 and 32.0 m for 8, 10, 12 and 14 mm nozzle size, respectively. Similar type of works have been conducted in the past by the Kamey and Rodmore (1984), Li and Kawano (1994) and jSonnar and Kapse (2006).

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