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Economic layout of Raingun for sugarcane crop

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Abstract **:** The research study entitled economic layout of raingun for sugarcane crop was carried out at different operating pressures *viz*., 2.0,2.5,3 and 3.5 kg/cm^2. The raingun of Jain-Komet twin 95 plus with nozzle size 16 mm diameter was used.Increase in pressure (2.0 to 3.5 kg/cm^2) increased discharge from 216 to 300lpm and radius of throw from 27 to 32.4 m. The uniformity coefficient was maximum (75.27 per cent) at 3.5 kg/cm^2 and minimum (72.59 per cent) at 2.5 kg/cm^2. The optimum spacing with maximum uniformity coefficient was 50 m at 3.0 kg/cm^2 with 30 per cent overlap. For square field of sugarcane the optimum length should be 55 m at 3.5 kg/cm^2 followed by 50 m at 3.0 kg/cm^2 and 40 m at 2.5 kg/cm^2 operating pressure. For rectangular field maximum uniformity was obtained when raingun spacing was 50x50x45m dimensions.

Key words **:** Raingun, Uniformity coefficient, Economic layout, Optimization

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Water has a key role to play in the progressive agriculture and economic development of the country. The stress in availability of water for agricultural sector is increasing due to stiff compition from industry as well as increasing demand from constantly growing population of the country. So its efficient utilization is very much essential for sustainable crop production. Maharashtra state is the third largest state in India with total geographical area of 30.8 mha and cultivable area of 21.89 mha.However, area under irrigation is only 3.87 mha which is 15.41 per cent of total cultivable area of state. The raingun irrigation system is recently introduced in the market as it is being adopted on small scale. In addition to study the economics, it is, therefore, necessary to study the labour, time, distribution pattern, uniformity coefficient, pressure-discharge relationship and maintenance of the system (Shinde *et al*., 2005). The Raingun system is useful for close growing crops like sugarcane, potato, groundnut, wheat, gram, vegetables etc. Sugarcane is important cash crop of Maharashtra state having 0.578mha area and 45.14 MT production (Singhal, 2003).The success of sugarcane farming depends upon efficient utilisization of irrigation water through suitable method. Raingun sprinkler not only found cost saving but also an efficient method for sugarcane over conventional method of irrigation (Khedkar, 2004). The efficiency of any sprinkler irrigation system depends on selection of optimum spacing with maximum uniformity coefficient at various operating pressures in the field. Therefore, the present study was carried out to develop economic layout with optimum spacing of raingun system.

METHODOLOGY

With a view to develop economic layout with optimum spacing of Raingun system for sugarcane a field experiment was conducted at Zonal Agricultural Research Station Shenda Park Farm, Kolhapur which is located at 16.43^0 N latitude and 74.59 ^{0} E longitude during July, 2007 to June, 2008. The rainguns of Jain-Komet twin 95 plus with nozzle size 16 mm diameter and 7.5 hp centrifugal pump were used for present study to provide prerequisite operating pressure for controlling the discharge with discharge regulating valve on delivery side. The field was fairly leveled. The type of soil is clayey with moderate infiltration rate. The catch cans were placed at each grade point. The raingun rotation was adjusted with the help of adjusting mechanism. The tests were conducted at pressures of 2.0, 2.5, 3.0 and 3.5 kg/cm^2. The discharge was measured by using watermeter for operating the system 5 minutes. The pressure-discharge relationship was established by plotting discharge against operating pressures. The radius of throw was measured using measuring tape.

Uniformity coefficient:

Uniformity coefficient was worked out using Christiansen's formula (Michel, 1978).

$$UC = 100\left(1 - \frac{\Sigma x}{m \times n}\right)$$

where, UC = Uniformity coefficient , Per cent

Σx= sum of absolute deviation of individual observations from the average, cm

m= average of all observations, cm

n= number of observations

Depth of precipitation:

Depth of precipitation is calculated by measuring the volume in each individual catch can by dividing that volume by the surface area of catch can. Precipitation distribution pattern was developed by using software surfer 32.

Optimum spacing:

The optimum spacing between the rainguns was found out as below. The rainguns were placed in open field to operate in 90^0 and were connected to the pumping unit. The grids were formed on the field at 5 m x 5 m upto 30 m length. The observations of precipitation depth taken for different nozzles for different operating pressures were considered one forth of the actual as the raingun operated at 90^0 only. These data were plotted on trace paper and the same data were used to make a half circle for each size at a particular pressure.The same grids and observations were taken on another trace paper in half circle. Then by overlapping these two trace up to 30, 50 and 60 per cent precipitation depths were added to calculate the overlapping UC between rainguns. The optimum spacing between rainguns was selected only when the UC was maximum under various set of conditions.

Economic layout:

Economic layout was developed by considering the optimum spacing of raingun at each pressure. The shape of field generally found was taken as two cases. If the shape of the field was square then the optimum length of square at each pressure was determined by considering maximum uniformity coefficient. For rectangular field the three dimensions X,Y, Z as shown in Fig. A was determined considering maximum uniformity.

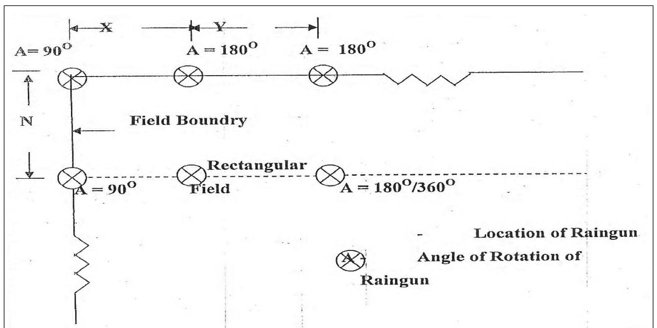

Fig. A : X,Y,Z dimensions of rectangular field

■ RESULTS AND DISCUSSION

The results of the present study as well as relevant discussion have been summarized under following heads:

Pressure discharge relationship:

The observations of pressure discharge relationship are given in Table 1, which shows that increase in pressure increased the discharge of the raingun system. The empirical equation of the form $Q = aH^b + C$ was fitted between discharge Q in lpm and pressure H in kg/cm^2.

$Q = 165.18\, H^{0.7343}$

R^2=0.994

Table 1 : Pressure, discharge and radius of throw of raingun at different operating pressures

Sr. No.	Operating pressure (kg/cm^2)	Average discharge (lpm)	Radius of throw (m)
1.	2.0	216	27.0
2.	2.5	240	30.5
3.	3.0	270	31.2
4.	3.5	300	32.4

Pressure-radius of throw relationship:

The data presented in Table 1 also show that increase in pressure increased the radius of throw of raingun. The relationship between pressure H in kg/cm^2 and radius of throw L in m was developed in the form of $L= aH^2 + bH - C$.

$L= 14.2514\, H^2 + 28.993\, H-13.774$

$R^2 = 0.968$

Uniformity coefficient:

The values of uniformity coefficients obtained for each operating pressure are given in Table 2. From the table it was concluded that UC for operating pressure of 3.5 kg/cm^2 was maximum (75.27 per cent) and minimum (72.59 per cent) at pressure 2.5 kg/cm^2.

Depth of precipitation:

Table 2 reveals that maximum precipitation rate of 2.57 cm/hr was observed at pressure 3.5 kg/cm^2 and followed by 2.44 cm/hr at pressure 3.0 kg/cm^2 and 2.30 cm/hr at pressure

Table 2 : Uniformity coefficient and average precipitation rate at different operating pressures

Operating pressure, kg/cm^2	Uniformity coefficient, percentage	Average precipitation, cm/hr
2.5	72.59	2.30
3.0	74.59	2.44
3.5	75.27	2.57

2.5 kg/cm^2.

Precipition distribution pattern:

The precipitation pattern obtained at pressures 2.5, 3.0, 3.5 kg/cm^2 is shown in Fig. 2, 3 and 4, respectively. It was clear that the precipitation volume decreased with increase in distance from raingun sprinkler. The precipitation was distributed uniformly in distinct intervals.

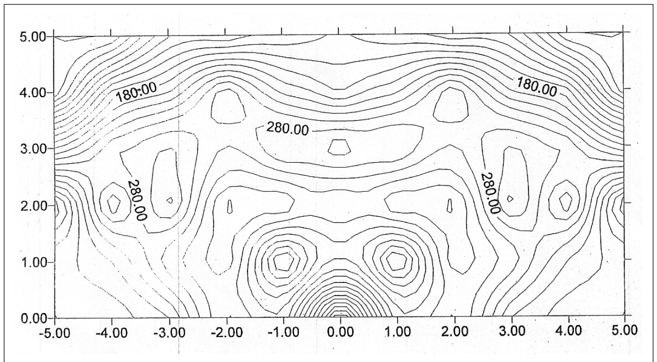

Fig. 1 : Precipitation distribution pattern at 2.5 kg/cm^2 pressure

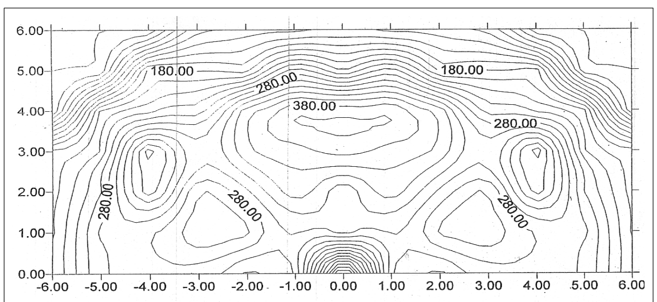

Fig. 2 : Precipitation distribution pattern at 3.0 kg/cm^2 pressure

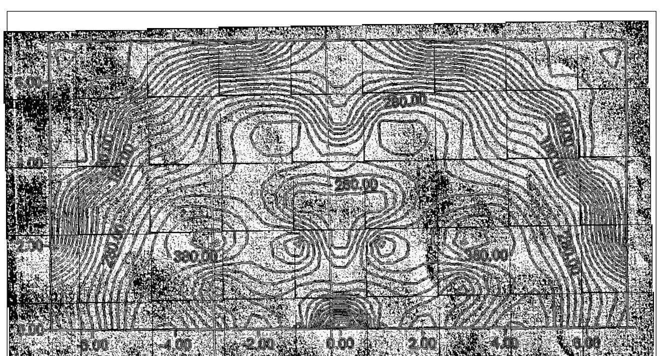

Fig. 3 : Precipitation distribution pattern at 3.5 kg/cm^2 pressure

Optimum spacing between raingun:

The calculated values of uniformity coefficients at different spacing between the raingun under different operating pressures are presented in Table 3. The table shows that the optimum spacing of 50 m with maximum uniformity coefficient (82.10) was obtained when raingun was operated at 3.0 kg/cm^2 pressure with 30 per cent overlap. At 2.5 kg/cm^2 operating pressure maximum uniformity (78.81) was 40 m spacing with 50 per cent overlap. At 3.5 kg/cm^2 operating pressure maximum uniformity (79.85) was 55m spacing with 50 per cent overlap. The uniformity values were lowest for all three operating pressures at 60 per cent overlap. This may be due to too close spacing between rainguns. Thus optimum spacing for raingun may be 40 m, 50 m and 55 m at 2.5, 3.0 and 3.5 kg/cm^2 operating pressures, respectively.

Table 3 : Percentage overlap, uniformity coefficient (UC) and optimum spacing (OS)

Pressure, kg/cm^2		Percentage overlap		
		30	50	60
2.5	UC (per cent)	78.22	78.81	75.34
	OS (m)	45	40	35
3.0	UC (per cent)	82.10	78.33	71.37
	OS (m)	50	45	40
3.5	UC (per cent)	78.06	79.85	76.52
	OS (m)	60	55	50

Economic layout for sugarcane:

The economic layout was developed by considering uniformity of water application and per cent overlap. The optimum spacing giving maximum uniformity not only reduces the cost of piping but also saves costly water (Dadiao and Welledsr, 1984).

Case I square field:

The optimum length of square was determined by considering maximum uniformity coefficient at various operating pressures.The optimum length of side of square increased with an increase in pressure (Table 4). For sugarcane crop 40 m length of side was adopted at 2.5 kg/cm^2 operating pressure. But for maximum uniformity, raingun may be operated at 3.0 kg/cm^2 with 50 m optimum length of square.

Table 4 : Optimum length of side of square field and UC at different operating pressures

Operating pressure, kg/cm^2	Optimum length of side, m	UC, per cent
2.5	40	78.81
3.0	50	82.10
3.5	55	79.85

Case II rectangular field:

The three distances X, Y and Z were determined for each operating pressure producing maximum uniformity. The optimum dimensions of rectangular field increased with and increase in pressure (Table 5). For sugarcane crop 40 m x 40 m x 35 m dimensions were adopted at 2.5 kg/cm^2 operating pressure. But for maximum uniformity raingun may be operated at 3.0 kg/cm^2 with 50 m x 50 m x 45 m dimensions of rectangular field.

Table 5 : X, Y and Z optimum dimensions for rectangular field at different operating pressures

Operating pressure, kg/cm^2	X (m)	Y (m)	Z (m)	UC, per cent
2.5	40	40	35	78.81
3.0	50	50	45	82.10
3.5	55	55	50	79.85

Conclusion:

Increase in operating pressure from 2.0 to 3.5 kg/cm^2 increased the discharge from 216 to 300 lpm and radius of throw from 27 to 32.40 m for the nozzle size of 16 mm diameter. The uniformity coefficient for operating pressure of 3.5 kg/cm^2 was maximum (75.27 per cent) and minimum (72.59 per cent) at 2.5 kg/cm^2 pressure. The maximum precipitation rate of 2.57 cm/hr, 2.44 cm/hr and 2.3 cm/hr was observed at pressure 3.5, 3.0 and 2.5 kg/cm^2, respectively. The optimum spacing of raingun was 50 m at 3.0 kg/cm^2 operating pressure with 30 per cent overlap and maximum uniformity coefficient. For square field of sugarcane the optimum length should be 55 m at 3.5 kg/cm^2 followed by 50 m at 3.0 kg/cm^2 and 40 m at 2.5 kg/cm^2 operating pressure. For rectangular field maximum uniformity was obtained when raingun spacing was 50 m x50 m x 45 m dimensions.

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REFERENCES

Dadiao,Chem and Welleder, W.W. (1984). Economic sprinkler selection spacing and orientation. *ASAE*, **27** (3): 737-743.

Khedkar, D.D. (2004). Efficiency of different sprinkler systems in improving the yield and quality of sugarcane. M.Tech. (Agril.Engg.) Thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri, AHMEDNAGAR, M.S. (India).

Michael,A.M. (1978). *Irrigation theory and practices*. Vikas publishing house Pvt. Ltd., New Delhi. pp. 644-645.

Shinde, B.K., Javeer, S.D., Mule, N.S. and Bhandore, R.K. (2005). Study on hydraulic performance of raingun sprinkler irrigation system. B.Tech. (Agril.Engg.) Thesis, Mahatma Phule Krishi Vidyapeeth, Rahuri, AHMEDNAGAR, M.S. (India)

Singhal,Vikas (2003). *Indian agriculture*. Published by Indian economic data research centre. pp. 772-793.

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