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Study on Uniformity Coefficient of some Common Micro-Sprinklers

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Abstract

A micro-sprinkler is a low volume sprinkler that operates at low pressure in contrast to high operating pressure of conventional sprinkler system. It require less energy than conventional sprinkler and less susceptible to clogging than drip emitter it has larger area of coverage than drip emitter but much lower than conventional sprinkler. Uniformity of water application is of the most importance for design of micro-sprinkler for being used for overlap pattern. For conventional sprinkler irrigation system Christansen Uniformity Coefficient is standardized 80% to 90% (ASAE, BIS). Such standardizations are also required for micro-sprinkler system.A experiment was conducted at G.B. Pant University of Agriculture and Technology, Pantnagar with three type of micro-sprinkler nozzles, at different pressures and at different riser heights to study the Christansen Uniformity Coefficient and to compare with conventional sprinkler system. Study shows that Christansen Uniformity Coefficient of conventional sprinkler irrigation system operating under high pressure are higher generally in a range of 80% to 90%. Micro-sprinkler irrigation system operating under low water pressure in any case do not reach the level of 80%. The range of uniformity coefficient for Jain (Blue) ranged 47.65% to 75.95%, Jain (Green) ranged -25.07% to 71.99% and Coromandel (Yellow) ranged -22.65% to 67.95% therefore the range of uniformity coefficient for Micro-Sprinkler should be taken as 50% to 70% for standardization of Micro-sprinkler. For farther categorization of uniformity coefficient more experimental data are required.

Key words : *Uniformity coefficient, micro-sprinkler, riser height, catch can.*

Introduction

To overcome the limitations of drip irrigation, micro-sprinkler irrigation was developed in early seventies. Micro-sprinkler irrigation system has specific common features of conventional sprinkler irrigation system and modern drip irrigation system. A micro-sprinkler is a low volume sprinkler that operates at low pressure in contrast to high operating pressure of conventional sprinkler irrigation system. It has much larger area of coverage than drip emitter but much lower than conventional sprinkler. Salient features of micro-sprinkler system are-low installation cost and maintenance cost, varying application rate and wetted area matching the crop and soil requirement, variable droplet size, multiple purpose system (fertilizer application, herbicide application, frost protection, cooling of green house and poultry house) and evenly and densely development of root system thus ensuring supply of water and nutrients to tree.

Uniformity of water application is one of the most important parameter for design and manufacture of micro-sprinkler irrigation for best water application and crop water use efficiency. For conventional sprinkler irrigation system Uniformity Coefficient is standardized 80% to 90% (1). Such a standardization are also required for micro-sprinklers system. A study was conducted with three type of micro-sprinkler nozzles to study the Uniformity Coefficient at different operating pressure and different riser height to compare with conventional sprinkler system.

(2) presented and equation to calculate uniformity coefficient of water distribution for a sprinkler system which is given below:

$$Cu = 100(1 - X/mn)$$

Where,

Cu = Christiansen Uniformity Coefficient, percent

X = Sum of absolute value of individual deviation from the average,mm

m = Average value of all observation, mm

n = Total number of observation point

A uniformity coefficient of 100% is indicative of absolutely uniform application. For conventional sprinkler irrigation system a Christiansen Uniformity Coefficient of 85% or considered to be satisfactory.

(3) on the basis of analysis of data of about 300 test on different parameters of sprinklers concluded that:

The uniformity of water distribution from sprinkler depend upon operating pressure, wind, rotation of sprinkler, spacing and many others factors.

With a portable system and with a sprinkler producing desirable patterns, good distribution can

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Table-1 : List of materials and equipments used for experiment.

Sl. No.	Item	Specification
1.	Pump	2.0 H.P., 3 phase, 415 volt, 2850 rpm, 40 mm x 40 mm size centrifugal pump
2.	Filter	Screen filter of Jain Irrigation System Ltd. of capacity 20 cum/hr having inlet and outlet dia. 63 mm
3.	Mainline	18m long, 63mm dia., PVC pipe having weight 0.67kg/m.
4.	Lateral line	Four LDPE lateral of 16mm dia. And 16m length each placed 4.5 m apart on main line
5.	Catch can	225 plastic cans of 10.5cm inside dia. And 15cm height were placed at 0.30x0.30m grid spacing
6.	Pressure Gauge	Bowiden type with range of 0-7kg/sqcm
7.	Measuring Cylinder	Graduated glass cylinder of 200ml capacity with least count of 2ml.

Table-2 : Specification of micro-sprinklers selected for study.

Sl. No.	Make	Orifice size, mm	Colour	Material Used
1.	Pasumai Finance and Industries(P) Ltd., Madras	2.00	Yellow	Plastic
2.	Jain Irrigation System Ltd., Jalgaon	1.57	Blue	Plastic
3.	Jain Irrigation System Ltd., Jalgaon	1.25	Green	Plastic

Table-3 : Christiansen uniformity coefficients of micro-sprinklers at different pressures and at different riser heights.

Riser height (cm)	Pressure (kg/sqcm)	Christiansen uniformity coefficients Cu (%)		
		Coromandel	Jain (Blue)	Jain (Green)
20	0.5	-22.65	53.82	-25.07
	1.0	33.73	60.37	-0.26
	1.5	63.40	61.26	21.14
	2.0	67.95	47.65	71.99
35	0.5	-15.21	56.72	43.42
	1.0	49.27	65.62	40.29
	1.5	52.25	70.84	60.59
	2.0	55.94	68.33	58.32
50	0.5	24.81	64.71	49.99
	1.0	32.40	70.15	63.37
	1.5	52.35	75.67	68.92
	2.0	54.59	72.62	68.38
65	0.5	-14.77	62.33	39.71
	1.0	24.35	68.68	60.62
	1.5	51.02	75.95	65.81
	2.0	52.23	71.15	64.75

be obtained when the line is moved not farther than 50% to 70% of the diameter covered by sprinkler, and when the spacing of sprinkler along the line is not more than 35% of diameter covered.

Sprinkler patterns are approximately conical where the maximum application occurs near the sprinkler and decreases gradually to the edge of the area covered, producing a uniform application when sprinklers are not farther apart than 55% to 60% of diameter covered.

(4) evaluated seven low flow sprinklers using (5) distribution characteristics (DC) method. They also evaluated Christiansen uniformity coefficient (Cu). On the basis of their study they concluded that :

They revised rating concept of poor versus good coefficient by lowering a good rating 70% to 80% using Christiansen (Cu) method.

Use of application uniformity method, such as Cu along with value to estimate variation among catch cans for that pattern i.e. coefficient of variation (Cv) should also be studied besides uniformity coefficients to check the uniformity pattern.

The Cu values greater than 50% and Cv value less than 40% allow the determination of the flattest possible pattern for non overlapping, low flow, spinner sprinkler.

Materials and Methods

Experiments were conducted using testing criteria of uniformity evaluation of conventional sprinkler by using ASAE and BIS procedure. Experimental site was located at the Threshing floor of Crop Research Center (CRC), G.B. Pant University of Agriculture and Technology, Pantnagar.The threshing floor was of concrete having slope approximately 1%. The site is situated at a latitude

of 29 degree North and longitude of 79 degree 18 minute East with altitude of 243.9 m above mean sea level. The average temperature, humidity, pan evaporation and wind speed prevailing at the time of experiment were 27.21 degree Celsius, 88.75%, 4.2 mm, and 4.7 km/hr respectively. The average temperature of water was 25 degree Celsius. The materials and equipment used during the study are presented in table-1.

Three different make of micro-sprinkler namely Coromandel (Yellow colour nozzle) and Jain (Blue and Green colour nozzle) were selected for study. The details of micro-sprinklers are given in table-2.

Experiments were conducted under pressure 0.5, 1.0, 1.5 and 2.0 kg/sq cm for 20 cm, 35 cm, 50 cm and 65 cm riser heights.

Four laterals and sixteen micro-sprinklers were used for one set of experiment. Four micro-sprinklers were laid on each lateral 4.5 m apart. The central portion of the 4.5m x 4.5m area was selected for taking the observation of amount of water collected in catch can placed on 0.30 x 0.30 m grid with the overlapping of micro-sprinklers.

The duration of operation was selected such that water caught in the catch can, could be recorded. It was observed that running of micro-sprinklers more than 30 minutes gave a reasonable depth, therefore micro-sprinklers were run for more than 45 minutes for each set. The experiment was conducted in morning hours and evening hours when wind speed was low and sunshine was minimum. After collecting required data Christiansen uniformity coefficients was calculated by equation (1).

Results and Discussion

The Christiansen Uniformity Coefficient (Cu) at different riser heights and at different operating pressures for three nozzles are presented below in table-3.

From table-3 it may be seen that no definite trend was found, but on an average with an increase in pressure there was an increase in Cu value for Coromandel Micro-Sprinkler at all riser heights. For Jain(Blue) Micro-Sprinkler, however, with an increase in pressure above 1.5 kg/sqcm, Cu value tends to decrease at all riser heights. For Jain (Green) Micro-Sprinkler an increase in Cu value is found with increase in pressure at riser height 20cm, beyond this riser height with an increase in pressure above 1.5kg/sqcm a decrease in Cu value was observed.

From table it is also clear that maximum Cu value was obtained for Jain (Blue) micro-sprinkler. In general, minimum value of Cu for all micro-sprinkler was found at 20 cm riser height and at 0.5 kg/sq cm operating pressure. Negative uniformity coefficient was found for Jain (Green) micro-sprinkler and Coromandel micro-sprinkler at lower pressure (0.5-1.0 kg/sq cm). The maximum uniformity coefficient for Jain (Blue) micro-sprinkler was found at the recommended pressure 1.5 kg/sq cm, while for Coromandel micro-sprinkler it was found at 0kg/sqcm pressure.

At recommended height (20 cm) and recommended pressure (1.5kg/sq cm) among all m Sprinklers maximum Cu value was found for Coromandel micro-sprinkler. The Jain (Blue) micro-sprinkler gave maximum uniformity coefficients at riser height more than 35 cm.

Conclusions

Uniformity coefficient of conventional sprinkler irrigation system operating under high pressure are higher generally, in range of 80% to 90%. Micro-sprinkler irrigation system operating under low water pressure in any case do not reach the limit of 80%. The range of uniformity coefficients for Jain (Blue) recorded 47.65% to 75.95%, Jain (Green) recorded -25.07% to 71.99% and Coromandel (Yellow) recorded -22.65% to 67.95%. The range for uniformity coefficients should be taken as 50% to 70% for standardization of micro-sprinklers. For further categorization of Cu more experimental data are required.

References

1. ASAE Standard (1990). Procedure for sprinkler distribution testing for research purposes. *Agric. Engineers* Year Book. Pp. 500-502.
2. Christiansen J.E. (1937). Irrigation by sprinkling, *Agric. Engg*. 18(2): 533-538.
3. Christiansen J.E. (1941). The uniformity of application of water by sprinkiling system. *Agric. Engg.,* 22(3): 89-92.
4. Post S.E.C., Peck D.E., Brendler R.A., Sakovich N.J. and Waddel L. (1984). Evaluation of non-overlapping, Low flow sprinklers. Drip/Trickle Irrigation in action. *Proceeding of the third international Drip/Trickle Irrigation Congress. Vol.,* 1: 293-305.
5. Merriam John L. and Keller Jack (1979). Farm Irrigation System Evaluation : A Guide for Management, *Agricultural and Irrigation Engineering Department,* Utah State University, Logan, Utah, pp. 255.