Distribution Uniformity and Uniformity Coefficient of Selected Microsprinklers

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Abstract

Five different types of microsprinklers were selected for identification as M-1, M-11, M-111, M-IV and M-V) for studying the Merrium and Keller Distribution Uniformity (DU) and Christiansen's Uniformity Coefficient (UCC). The DU and UCC were studied at different spacing of microsprinkles and different pressures. The pressures were in the range of 1.0 to 2.0 kg/cm^2 with and increment of 0.5 kg/cm^2 and the spacings between microspinklers were 3 x 3 m to 10 x 10 m with an increment of 1.0 m (i.e. 3 x 3 m, 4 x 4 m ....., 10 x 10.0 m). The M-V has shown maximum UCC, 94.74 percent at 2 kg/cm^2 pressure at the psacing of 3 x 3 m., and the lowest by M-IV i.e. 87.52 percent. More than desired value (70%) of UCC was reported only for MS-I for all pressures under consideration and for spacings 3 m x 3 m to 7 m x 7 m which indicates its superiority over other types of microsprinklers. The highest value of DU, 96.90 percent was recorded for M-II at 2.0 kg/cm^2.

Keywords: Distribution uniformity; Microsprinkler spacings; Uniformity coeffieicnet.

Introduction

The emitting devices such as drippers, foggers, microsprinklers, etc. may or may not be emitting the right quantity of water at recommended pressures. Reduced water application uniformity or uneven distribution of irrigation water hamper the crop growth and subsequently lower production from the unit area. Sprinkler or microsprinkler irrigation uniformity is characterized by uniformity coefficients based on some measure of dispersion or scatter of the precipitation distribution. These coefficients are useful parameters of the irrigation practice and serve as a basis for the selection of sprinkler or microsprinkler systems.

Uniformity largely depends on the overlapping, spacing between microsprinklers, pressure and subsequently discharge. The irrigation engineers can use the information of UCC based on spacing between microsprinklers (Tarjuelo *et al*, 1999).

Materials and Methods

The experiment was conducted on selected five makes of microsprinklers M-I, M-II, M-III, M-IV and M-V in view of testing for uniformity and distribution of uniformity, the experiment was conducted with five different makes of microsprinklers, designated as, at different pressures and spacing combinations. The ASAE-S 330.1 guidelines (ASAE, 2003) and BIS (1984) guidelines were applied. The experiment was conducted during the early in the morning so as to avoid the drifting losses due to low wind velocity in the morning. Catch cans were placed at grid points of 50 cm x 50 cm on concrete floor. Collected water in the catch cans was measured and converted in

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terms of depth and subsequently the UCC and DU was found our for each micrposprinkler spacing and applied pressure.

Determination of UCC and DU

At each pressure and microsprinkler spacing the UCC i.e. Christiansen's uniformity coefficient (1941) and DU i.e. Merriam and Keller's Distribution Uniformity (1978), were calculated.

Christiansen's uniformity coefficient (UCC)

$$UCC = 100 \left(1 - \frac{\sum_{i=1}^{N} |X_i - X|}{N X} \right)$$

Where, N = No of observations taken

$\sum_{i=1}^{N} |X_i - X|$ = addition of absolute individual observation's deviations , X_i , from average X

DU

The distribution uniformity given by Merriam and Keller is as under.

$$DU = \frac{\text{Mean depth of water received in lower quarter}}{\text{Mean water depth}} \times 100$$

Results and Discussion

Christiansen's uniformity coefficient (UCC)

The values of UCC obtained for different microsprinkler spacing and respective pressure are depicted in Table 1.

Distribution uniformity (DU)

The values of DU are depicted in Table 2. The results in regard of DU were also in similar trend as recorded by Seginer (1963), Sakore (1992) and Shinde and Darde (1993).

Table 1:

| Spacing (m) | Pressure | Christiansen's uniformity coefficient | | | | |
| | | Make of Microsprinkler | | | | |
		M-I	M-II	M-III	M-IV	M-V
3 x 3	2.0 kg/cm²	91.03	92.06	92.50	87.52	94.74
4 x 4		90.84	84.39	89.41	81.92	92.37
5 x 5		86.64	79.33	87.45	58.03	86.31
6 x 6		80.88	75.57	80.62	38.74	83.07
7 x 7		77.78	67.08	63.78	6.13	79.14
8 x 8		69.55	54.24	47.92	0	71.99
9 x 9		58.57	36.35	29.80	0	57.70
10 x 10		42.68	17.37	11.36	0	38.98
3 x 3	1.5 kg/cm²	90.85	89.26	92.3	86.80	91.42
4 x 4		89.20	83.90	88.11	80.50	88.37
5 x 5		83.40	76.12	87.37	50.96	85.90
6 x 6		79.92	68.91	75.92	20.43	80.63
7 x 7		76.60	59.82	60.96	0	68.36
8 x 8		67.00	48.09	42.63	0	47.14
9 x 9		56.50	24.27	26.36	0	25.31
10 x 10		41.79	4.34	9.28	0	5.81
3 x 3	1.0. kg/cm²	90.75	89.10	89.80	84.10	90.56
4 x 4		87.69	82.80	87.67	58.77	84.43
5 x 5		81.97	72.47	81.14	30.00	83.90
6 x 6		78.45	59.48	75.58	1.09	78.30
7 x 7		74.93	35.04	55.84	0	56.90
8 x 8		66.41	11.53	41.95	0	36.49
9 x 9		51.79	0	25.27	0	15.22
10 x 10		39.29	0	8.88	0	0

Table 2: Distribution uniformity for microsprinklers

| Spacing (m) | Pressure | Christiansen's uniformity coefficient | | | | |
| | | Make of Microsprinkler | | | | |
		M-I	M-II	M-III	M-IV	M-V
3 x 3	2.0 kg/cm^2	91.47	96.90	92.61	90.35	96.75
4 x 4		87.65	90.24	89.84	75.12	88.31
5 x 5		79.65	78.90	87.11	44.67	78.70
6 x 6		74.35	69.20	66.31	15.69	73.34
7 x 7		64.72	61.46	45.54	8.24	71.97
8 x 8		58.12	44.16	36.87	0.00	66.70
9 x 9		33.64	17.12	19.33	0.00	42.70
10 x 10		0.40	0.00	0.12	0.00	0.18
3 x 3	1.5 kg/cm^2	90.56	92.84	90.90	88.98	86.00
4 x 4		87.84	89.00	88.59	70.10	83.00
5 x 5		73.20	75.65	87.78	37.09	82.03
6 x 6		71.00	45.15	56.70	10.65	77.60
7 x 7		66.81	23.08	42.01	0.00	52.09
8 x 8		57.50	16.45	34.89	0.00	25.00
9 x 9		27.60	0.00	17.03	0.00	6.99
10 x 10		0.23	0.00	0.05	0.00	0.04
3 x 3	1.0. kg/cm^2	90.13	91.90	88.55	81.10	83.98
4 x 4		86.24	85.41	87.10	46.90	77.84
5 x 5		74.23	70.66	86.50	15.80	76.77
6 x 6		73.80	37.60	55.36	0.00	70.70
7 x 7		63.97	9.62	41.00	0.00	47.53
8 x 8		55.07	0.00	27.00	0.00	23.10
9 x 9		29.16	0.00	13.45	0.00	0.00
10 x 10		0.13	0.00	0.04	0.00	0.00

Conclusions

1. The UCC decreases with microsprinkler spacing.
2. If the operating pressure increases, overall uniformity increases.
3. DU was more affected by spacing than pressure.
4. M-I was found superior over microspinklers in respect of higher UCC and DU.

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