International Journal of Agricultural Engineering, Vol. 4 No. 2 (October, 2011) : 130 -132

Research Paper :

Effect of nozzle size on evaporation and drift losses from mini-sprinkler

S.A. KADAM AND V.V. DESHMUKH

Received : March, 2011; Revised : May, 2011; Accepted : July, 2011

See end of the article for authors' affiliations

Correspondence to:

S.A. KADAM
Department of Irrigation and Drainage Engineering, Dr. A.S. Shinde College of Agricultural Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri, AHMEDNAGAR (M.S.) INDIA

ABSTRACT

Evaporation and wind drift losses from the mini-sprinkler under different combinations of climatic and operating conditions were determined. The evaporation and drift losses increased with small nozzles and decreased with large nozzle size. This may be due to the fact that small nozzles produce large quantities of small droplets which are susceptible to hot, dry and windy conditions. The losses ranged from 11.95 to 23.41%, 6.22 to 29.93% and 5.49 to 14.90 % at 1.5, 2.0 and 2.5 kg/cm^2 operating pressure for 1.94, 2.10 and 2.50 mm nozzle sizes.

Kadam, S.A. and Deshmukh, V.V. (2011). Effect of nozzle size on evaporation and drift losses from mini-sprinkler. *Internat. J. Agric. Engg.*, **4**(2) : 130-132.

Key words : Nozzle size, Evaporation and drift losses, Mini-sprinkler

Evaporation and wind drift losses in sprinkler irrigation have been the subject of numerous field, laboratory and analytical studies. A wide range of losses have been reported in the literature due to the many design, climatic and operation parameters involved in evaporation and wind drift losses. These losses are taken as the difference between the amount of water leaving the nozzle and that measured with a grid network of catch cans. The losses were approximately proportional to wind velocity and operating pressure and inversely proportional to nozzle size and relative humidity of the air (Frost and Schwalen, 1955). Strong (1961) found that evaporation and wind drift losses increased as the riser height of sprinkler increased. Kraus (1966) found that evaporation and wind drift losses ranged from 3.4 to 17%, and 36% of these losses was due to wind drift. Sternberg (1967) reported that wind drift losses were 60% of the total loses. Hermsmeier (1973) found that evaporation and wind drift losses can range from 0 to 50%, and these losses are more closely related to air temperature and application rate than to wind velocity or relative humidity. Abo-Ghobar (1993) reported that average evaporation and drift losses ranged from7.5 % for single nozzle of 2.29 mm diameter to 22.6 % for double nozzle sprinkler of diameter 6.1 x 3.0 mm. The evaporation and wind drift losses are highest when sprinklers that produce large quantities of small droplets are operated in hot, dry windy conditions (Frost and Schwalen, 1955). The application efficiency of sprinkler irrigation system can be significantly influenced by the amount of evaporation and wind drift losses. The magnitude of these losses depends upon the climatic and operating conditions. To obtain and insight into the magnitude of these losses, it is necessary to determine the factors affecting evaporation and drift losses from mini-sprinklers under local conditions. There is very little information available on evaporation and wind drift losses at different operating conditions such as riser height and nozzle size. Therefore, the experiment was conducted to study the evaporation and drift losses from mini-sprinkler irrigation system under different operating conditions.

METHODOLOGY

The experiment was conducted to study the effect of nozzle size on evaporation and drift losses from mini-sprinkler irrigation system at the Instructional Farm of Department of Irrigation and Drainage Engineering, Dr. A. S. College of Agricultural Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri. Three commercially available mini-sprinklers of nozzle size 1.94 mm, 2.10 mm and 2.50 mm were used for the study. The mini-sprinklers were tested at 1.5, 2.0 and 2.5 kg/cm^2 pressure to find the effect of nozzle size on evaporation and drift losses in mini-sprinklers. The observations on flow rate, gross depth of application, depth reaching the catch can were recorded by placing the mini-sprinkler centrally and forming the grids of size 12 x 12 m around it for all the combinations of nozzle size, pressures and climatic factors like wind velocity, temperature and relative humidity. The observation of temperature, wind velocity and relative humidity are recorded at an interval of every 10 minutes during the test run with the help of thermometer, hygrometer and anemometer, respectively. The average values these parameters are calculated for the each nozzle type. The gross depth of application and depth reaching the catch cans was determined by using concentric ring method given by Keller and Merrian (1978). The evaporation and wind drift losses were calculated by, $E = [(d_1-d_2) / d_1] X 100$, where, E = mini-sprinkler evaporation and wind drift losses [%]; d_1 = gross water depth applied by sprinkler (mm), d_2 = water depth reaching catch cans (m). The evaluation tests were conducted in accordance with ASAE Standards.

RESULTS AND DISCUSSION

A series of tests were made with a single nozzle mini- sprinklers under field conditions to study the evaporation and drift losses from mini-sprinkler irrigation system. The results of climatic and operation parameters like nozzle size, temperature, wind speed, relative humidity and their effects on evaporation and wind drift losses are presented in the Table 1.

The values of evaporation and drift losses for nozzle sizes 1.94, 2.10 and 2.50 mm varies from 5.49 to 11.95 %, 6.22 to 19.45 % and 7.42 to 19.40 % at 1.5, 2 and 2.5 Kg/cm^2 pressure, respectively at 0.45 m riser height. The values of evaporation and drift losses for nozzle sizes 1.94, 2.10 and 2.50 mm varies from 11.38 to 12.63 %, 10.08 to 22.15 % and 13.25 to 21.28 % at 1.5, 2 and 2.5 Kg/cm^2 pressure, respectively at 0.60m riser height. The values of evaporation and drift losses for nozzle sizes 1.94, 2.10 and 2.50 mm varies from 14.08 to 16.17 %, 13.59 to 22.26 % and 14.90 to 29.93 % at 1.5, 2 and 2.5 Kg/cm^2 pressures, respectively at 0.75 m riser height. In general it was found that when the mini-sprinkler of nozzle size 1.94 mm, 2.10 mm and 2.50 mm were operated at 0.45 m and 0.60 m riser heights, the evaporation and drift losses

Table 1 : Effect of nozzle size on evaporation and drift losses from mini-sprinkler

Riser height (m)	Pressure (kg/cm^2)	Nozzle size (mm)	Wind speed (km/hr)	Temp. (^{0}C)	RH (%)	E (%)
0.45	1.5	1.94	3.11	31.94	31.11	11.95
		2.10	5.11	36.91	25.49	11.69
		2.50	6.14	31.43	26.13	5.49
	2.0	1.94	6.41	40.6	34.26	19.45
		2.10	8.36	35.47	28.1	6.22
		2.50	2.87	27.47	38.3	7.71
	2.5	1.94	2.42	29.69	45.37	19.40
		2.10	3.53	29.71	36.54	11.29
		2.50	4.09	22.76	45.8	7.42
0.60	1.5	1.94	3.73	33.5	25.1	12.53
		2.10	2.99	38.53	23.54	12.63
		2.50	1.31	31.93	30.16	11.38
	2.0	1.94	3.89	20.41	24.24	22.15
		2.10	4.4	37.53	24.19	16.72
		2.50	2.59	30.09	31.81	10.08
	2.5	1.94	4.53	33.64	33.17	21.28
		2.10	1.94	29.83	31.91	20.50
		2.50	4.13	31.97	28.29	13.25
0.75	1.5	1.94	1.74	27.79	35.99	16.17
		2.10	2.39	38.5	23.49	15.42
		2.50	5.89	30.81	24.53	14.08
	2.0	1.94	2.57	30.3	34.76	22.26
		2.10	2.51	32.37	25.07	19.41
		2.50	3.94	29.81	29.47	13.59
	2.5	1.94	2.6	25.5	37.94	23.41
		2.10	3.4	36.11	30.76	29.93
		2.50	3.67	32.59	23.3	14.90

found increased from nozzle size 1.94 to 2.10 mm and then decreased as nozzle size increased to 2.50 mm. However, the evaporation and drift losses found decreased from nozzle size 1.94 to 2.50 mm except nozzle size of 2.10 mm operated at 2.5 kg/cm^2 pressure.

The evaporation and drift losses from different nozzle sizes were determined and shown in Fig.1. This figure indicated the influence of nozzle sizes on evaporation and drift losses at different operating pressures and riser heights. The losses increased with small nozzles and decreased with large nozzle size. This may be due to the fact that small nozzles produce large quantities of small droplets which are susceptible to hot, dry and windy conditions. This study suggests that the losses from the mini-sprinklers could be minimized if it is operated with large nozzle size and at lower riser heights, particularly in areas with limited resources of water and under hot and dry conditions.

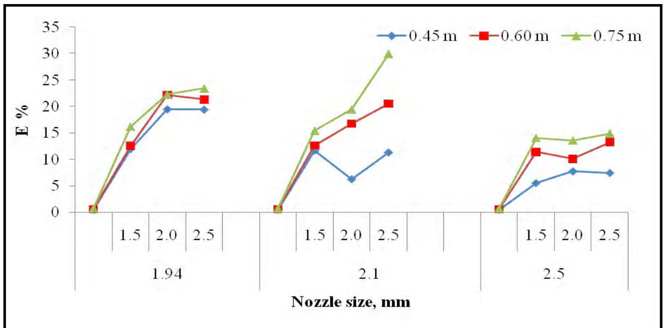

Fig. 1 : Effect of nozzle size on evaporation and drift losses in mini-sprinkler

Conclusion:

This study was conducted to determine the evaporation and with drift losses during sprinkling under various climatic and operation conditions. The losses are dependent upon both climatic and operating factors and ranged for the tested mini-sprinklers from 11.95 to 23.41%, 6.22 to 29.93% and 5.49 to 14.90 % at 1.5, 2.0 and 2.5 kg/cm^2 operating pressure according to nozzle sizes and riser heights.

The evaporation and drift losses indicated that the nozzle size was the predominate factors affecting the evaporation and wind drift losses.

The study is expected to draw the attention of sprinkler irrigation system designers and users to the importance of selecting the proper nozzle size. Also, the climate factors should be considered during design and evaluation of the system. This will lead to save energy and conserve water in areas of limited water supply.

Authors' affiliations:
V.V. DESHMUKH, College of Agricultural Engineering and Technology, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, RATNAGIRI (M.S.) INDIA

REFERENCES

Abo-Ghobar. H.M.(1993). Evaporation and drift losses from sprinkler irrigation systems under hot and dry conditions. *J. King Saud Univ. Agric .Sci.,* **20**:153-164.

ASAE Standers ASAE 330.1 (1987). Procedure for Sprinkler Distribution Testing for Research Purpose. Agricultural Year book.

Frost, K. R. and Schwalen, H.C. (1955). Sprinkler evaporation losses. *Agric. Engg.,* **6**(8) : 526-528.

Hermsmeier, L.F. (1973). Evaporation during sprinkler application in a desert climate. *ASAE Paper*, **73**: 216

Keller J. and J. L. Merriam, (1978). *Farm irrigation system evaluation. A duide for management, agriculture and irrigation engineering*, Utah State, University Logan, Utah, pp. 255.

Krus, J.H. (1966). Application efficiency of sprinkler irrigation and its effects of microclimate. *Trans. ASAE, 9,* **5**: 642-645

Sternberg, M.Y. (1967). Analysis of sprinkler irrigation losses. Proc. ASCE, J, Irrig. Drain. Div, 92: 111-124.

Strong, W.C (1961). Advanced irrigation. Proc of an Intl. Irrig. Symp. Southern Rhodesia: pp.242-246.

***