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Research Paper :

Effect of riser height on evaporation and drift losses in mini-sprinkler

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ABSTRACT

The evaporation and drift losses increase with increase in riser height. The evaporation and drift losses were found in the range of 5.49 % to 29.93 % for all the three mini-sprinklers when they are operated at riser height of 0.45m, 0.60 m and 0.75 m at operating pressure of 1.5, 2.0 and 2.5 kg/cm^2, respectively. The losses were found increased with increase in operating pressure also. The evaporation and drift losses indicated that the riser height and nozzle size were the predominate factors affecting the evaporation and wind drift losses.

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Key words : Riser height, Evaporation and drift losses, Mini-sprinkler

With population growth in the world, the demand for water is increasing. Hence, the necessity for conservation of water resources increase, particularly in countries of limited water supply, where the agricultural irrigation has traditionally been the major water use sector in these areas. Thus, the water application efficiency is becoming increasingly important as energy and water costs rise and water conservation area emphasized. This increase need for better design and management of sprinkler systems. Sprinkler irrigation evaporation and wind drift losses 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 were due to wind drift. Sternberg (1967) reported that wind drift losses were 60% of the total losses. Kohl *et al.* (1987) reported that evaporation and drift losses ranged from 0.4 to 1.4% and that small droplets are more susceptible to evaporation and wind drift losses. 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 to know the effect of riser height on evaporation and drift losses in mini-sprinkler was conducted.

METHODOLOGY

The field study described in this paper was carried out at the Instructional Farm of the Department of Irrigation and Drainage Engineering, Dr. A. S. College of Agricultural Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri during 2008-2009. The evaluation tests were conducted in accordance with ASAE Standards (1987). A series of tests were made using a single stationary mini-sprinkler system to determine the evaporation and drift losses and the effect of riser height on the quantity of these losses. 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 0.45, 06.0 and 0.75 m risers, respectively at 1.5, 2.0 and 2.5 kg/cm^2 pressure to find the effect of nozzle size on evaporation and drift losses. 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 gross depth of application and depth reaching the catch cans was determined by using concentric ring method given by Keller and Merriam (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).

RESULTS AND DISCUSSION

A series of tests were made with a single nozzle mini- sprinklers under field conditions to determine the effects of riser height on evaporation and wind drift losses for the tested sprinklers. The results of climatic and operation parameters and their effects on evaporation and wind drift losses are presented in the Table 1. The average losses ranged from 6.22% for 2.5 mm nozzle size at height 0.45 m to 22.26% for 2.10 mm nozzle size at 0.45 m riser height. The evaporation and wind drift losses from the tested mini-sprinklers varied widely. This may be due to the changes in climatic and operation factors during the tests.

The effect of riser height on evaporation and drift losses from mini-sprinkler nozzles are shown in Fig.1. It can be seen that the losses increased with increasing the riser height.

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.

Table 1: Effect of riser height on evaporation and drift losses in mini-sprinkler

Nozzle size, mm	Pressure, kg/cm^2	Riser height, m	Wind speed, km/hr	Temp., ^{0}C	RH, %	d1, mm	d2, mm	E, %
1.94	1.5	0.45	3.11	31.94	31.11	2.82	2.48	11.95
		0.60	3.73	33.5	25.1	2.92	2.56	12.53
		0.75	1.74	27.79	35.99	2.51	2.11	16.17
	2.0	0.45	6.41	40.6	34.26	2.67	2.15	19.45
		0.60	3.89	20.41	24.24	2.67	2.08	22.15
		0.75	2.57	30.3	34.76	2.58	2.01	22.26
	2.5	0.45	2.42	29.69	45.37	2.31	1.86	19.40
		0.60	4.53	33.64	33.17	2.54	2.00	21.28
		0.75	2.6	25.5	37.94	2.49	1.91	23.41
2.1	1.5	0.45	5.11	36.91	25.49	2.21	1.95	11.69
		0.60	2.99	38.53	23.54	1.95	1.70	12.63
		0.75	2.39	38.5	23.49	1.72	1.46	15.42
	2.0	0.45	8.36	35.47	28.1	2.38	2.23	6.22
		0.60	4.4	37.53	24.19	2.05	1.71	16.72
		0.75	2.51	32.37	25.07	2.36	1.90	19.41
	2.5	0.45	3.53	29.71	36.54	2.31	2.05	11.29
		0.60	1.94	29.83	31.91	2.32	1.85	20.50
		0.75	3.4	36.11	30.76	2.41	1.69	29.93
2.5	1.5	0.45	6.14	31.43	26.13	2.55	2.41	5.49
		0.60	1.31	31.93	30.16	2.40	2.13	11.38
		0.75	5.89	30.81	24.53	2.16	1.86	14.08
	2.0	0.45	2.87	27.47	38.3	2.24	2.07	7.71
		0.60	2.59	30.09	31.81	2.58	2.32	10.08
		0.75	3.94	29.81	29.47	2.27	1.96	13.59
	2.5	0.45	4.09	22.76	45.8	2.51	2.32	7.42
		0.60	4.13	31.97	28.29	2.19	1.90	13.25
		0.75	3.67	32.59	23.3	2.84	2.41	14.90

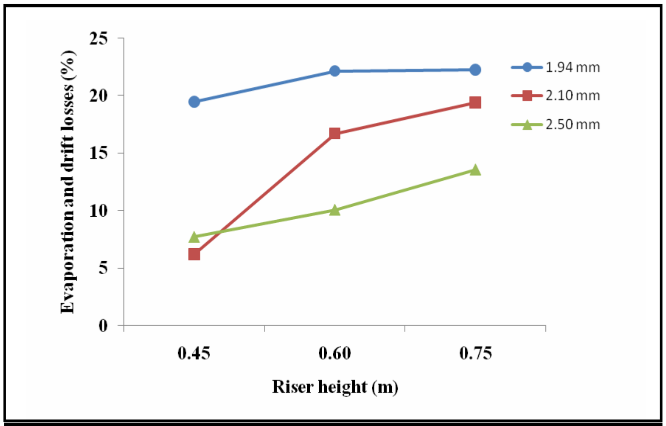

Fig. 1 : Geometric parameters used to determine soil profile after tillage

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 5.49 % to 29.93 %.The evaporation and drift losses indicated that the riser height and nozzle size were 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 riser height and 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.

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