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INFLUENCE OF CLIMATIC FACTORS OVER THE DRIFT LOSS IN SPRINKLER IRRIGATION

R.M. PADMANABHAN and D.CHANDRASEKARAN

College of Agricultural Engineering
Tamil Nadu Agricultural University
Kumulur 621 712

ABSTRACT

A field experiment was conducted to assess the effect of climatic factors *viz.*, wind velocity, relative humidity and atmospheric temperature over the drift loss under sprinkler irrigation. The influence of climatic factors, Sixteen combinations of four sprinkler nozzle diameters and four pressures were studied for each irrigation with *ragi* as test crop. It was found that only wind velocity had consistant, positive and significant influence on the drift loss.

KEY WORDS : Sprinkler Irrigation, Drift Loss, Climatic Factors, Influence

Sprinklers are becoming popular all over the world by virtue of their enhanced water use efficiency and ease of operation. They are specially suited to such areas which could not be irrigated by conventional methods of surface irrigation efficiently and economically. These are invariably adopted for row crops, pastures and orchard crops by applying water at a rate lesser than the infiltration capacity of the soil. Their application in hilly areas for irrigating the vegetables and plantation crops is well known. The performance of sprinkler irrigation as a system depends upon climatic/environmental factors prevailing at the time and place of irrigation. Frost and shwalen (1955) found close relationship between sprinkler efficiency and environmental factors like relative humidity, temperature and wind velocity. Kraus (1966) and Ido Seginer (1969) stated that wind speed significantly controlled the water loss by drifting the water drops away from the sprinkler pattern.

The present study was carried out to assess the influence of climatic factors on the dirft loss in sprinkler irrigation system with wind velocity, atmospheric temperature and relative humidity as parameters.

MATERIALS AND METHODS

A field experiment with *ragi* as test crop was conducted in a well drained sandy loam soil at the Tamil Nadu Agricultural University campus, Coimbatore during *rabi* 1992. An adjoining uncropped field was taken up as control for mass balancing of water. The sprinkler type employed in the study was twin nozzle, single riser No.4 with rotary male connection.

Four nozzles of different diameters were employed under four operational pressures. The diameter of nozzles used in the study were (i) 3.97 mm x 2.38 mm (ii) 4.76 mm x 2.38 mm (iii) 5.56 mm x 3.17 mm, and (iv) 6.35 mm x 3.17 mm. The pressures applied were 1.2 KSC, 2.5 KSC, 3.5 KSC and 4.0 KSC. The required pressure was set by regulating the water flow through a gate valve fitted at the main line. A portion of the discharge form the pump was recycled back to the supply tank through a by pass valve. The total quantity of water needed for each irrigation was equally divided into 16 parts and the crop was irrigated with all the 16 combinations of 4 nozzles and 4 pressures. However, the duration of operation was not constant as the discharge capacity of nozzles varied with their diameters. The quantity of water let into the system was measured with a water meter. The quantity reaching the soil surface was known through catch cans placed at a spacing of 3 m x 3 m in a square grid net work. The loss of water by drift was calculated by the method of mass balance after dedcuting evaporation component. The data were subjected to statistical analysis without transforming the percentages since the data were assumed to be distributed normally.

RESULTS AND DISCUSSION

The effect of climatic factors including wind velocity, relative humidity and atmospheric temperature over the drift loss in sprinkler irrigation was estimated and presented below.

Table 1. Co-efficient of correlation between drift loss and wind velocity (N=40)

Treatment	N_1	N_2	N_3	N_4	P_1	P_2	P_3	P_4
Mean wind velocity	8.55	7.98	8.39	8.66	8.94	8.63	8.16	7.85
Mean drift loss	10.74	8.43	9.06	9.82	8.62	9.76	10.15	9.95
r values	0.4543	0.5904	0.9406	0.9200	0.8601	0.7979	0.8501	0.8576

N_1 = 3.97 mm x 2.38 mm; P_1 = 1.2 KSC
N_2 = 4.76 mm x 2.38 mm; P_2 = 2.5 KSC
N_3 = 5.56 mm x 3.17 mm; P_3 = 3.5 KSC
N_4 = 6.35 mm x 3.17 mm; P_4 = 4.0 KSC

Effect of wind velocity on the drift loss

The study of wind velocity and drift loss established a direct relationship between them. The co-efficients of correlation between dirft loss and wind velocity under different nozzle diameters and pressures are presented in Table 1. The co-efficients indicate that there is high and positive correlation between drift loss and wind velocity under all nozzle sizes and pressures. This is ascribed to the fact that with increase in wind velocity more of water particles coming out of sprinkler nozzles must have been carried away to distant place outside the marked area of opertion of sprinkler resulting in increased drift loss. Similar findings were reported by Chawla and singh (1977) while studying the sprinkler irrigation losses as affected by climatic and operating conditions.

EFFECT OF RELATIVE HUMIDITY AND ATMOSPHERIC TEMPERATURE ON DRIFT LOSS

The effect of relative humidity and atmospheric temperature over the drift loss is negligible since their regression co-efficients are not significant. The multiple regression equation for predicting the drift loss based on the prevailing wind velocity, relative humidity and atmospheric temperature were worked out for different nozzles and operating pressures and presented in table 2. The R^2 values were high under all treatments except under N_1 (3.97 x 2.38mm) and N_2 (4.76 x 2.38 mm) and it ranged between 0.6726 and 0.8994 indicating that 67% to 90% of the variation in drift loss was due to the climatic factors considered in the study. However, the regression co-efficients of relative humidity and atmospheric temperture were not significant indicating that their contribution is negligible. Probably these two factors influence some other loss like evaporation which need separate study.

With a view to make the regression co-efficients comparable standard multiple regression equations were developed and presented in Table 3. Only wind velocity had consistant, high, positive and significant regression co-efficients under varying treatments, indicating that wind influence the drift loss very much.

From the above data it may be concluded that to reduce drift loss it is better to operate the sprinklers under low wind conditions. Similar findings were reported by Inove (1963) and Chawla (1977) while studying the spray drift with wind movement.

Table 2. Multiple regression equations for predicting drift loss (N=40)

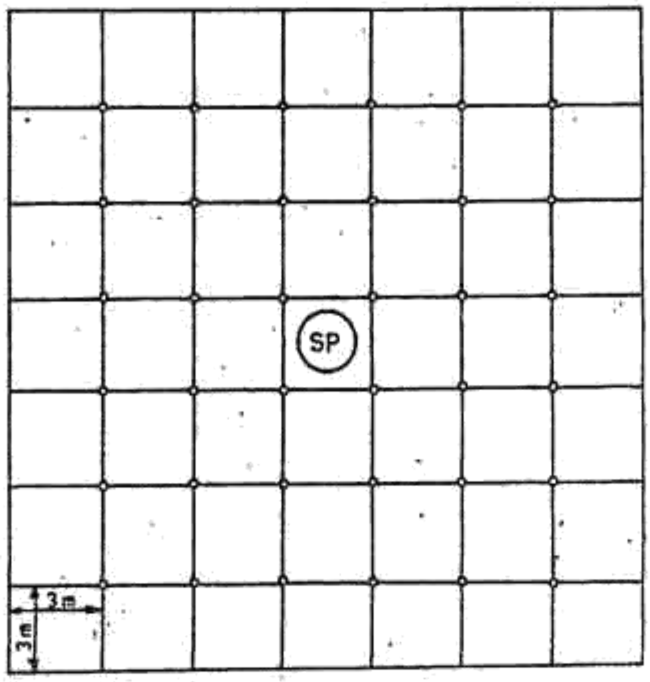
Under N_1, $Y_2 = 18.179^{+} + 0.1272\ X_1 - 0.1528\ X_2 - 0.7787\ X_3$	$R^2 = 0.2899^{+}$
Under N_2, $Y_2 = -1.0491 + 0.3874^{+}\ X_1 + 0.0417\ X_2 + 0.1226\ X_3$	$R^2 = 0.3664^{+}$
Under N_3, $Y_2 = 12.1718 + 1.0645^{+}\ X_1 - 0.1236\ X_2 - 0.1351\ X_3$	$R^2 = 0.8994^{+}$
Under N_4, $Y_2 = 31.5864^{+} + 0.7703^{+}\ X_1 - 0.1315\ X_2 - 0.7180\ X_3$	$R^2 = 0.8717^{+}$
Under P_1, $Y_2 = 20.6205 + 0.6655^{+}\ X_1 - 0.1294\ X_2 - 0.3468\ X_3$	$R^2 = 0.7658^{+}$
Under P_2, $Y_2 = 25.8755^{+} + 0.6923^{+}\ X_1 - 0.1651^{+}\ X_2 - 0.4139\ X_3$	$R^2 = 0.6728^{+}$
Under P_3, $Y_2 = 15.8831 + 1.0195^{+}\ X_1 - 0.0904\ X_2 - 0.2838\ X_3$	$R^2 = 0.7287^{+}$
Under P_4, $Y_2 = 14.4084 + 1.3335^{+}\ X_1 - 0.1058\ X_2 - 0.2960\ X_3$	$R^2 = 0.7459^{+}$

X_1 = Wind velocity; X_2 = Relative humidity; X_3 = Atmospheric temperature; Y_2 = Drift loss; + Significant at 5% level
N_1 = 3.97 mm x 2.38 mm; P_1 = 1.2 KSC
N_2 = 4.76 mm x 2.38 mm; P_2 = 2.5 KSC
N_3 = 5.56 mm x 3.17 mm; P_3 = 3.5 KSC
N_4 = 6.35 mm x 3.17 mm; P_4 = 4.0 KSC

Table 3. Relationship between drift loss and wind velocity, relative humidity and temperature under different nozzle sizes and operating pressures (N40)
(Standard multiple regression equation)

Under N_1, $Y_2 = 41.0047^+ + 0.1175\ X_1 - 0.44497\ X_2 - 0.7787\ X_3$	$R^2 = 0.2899^+$
Under N_2, $Y_2 = -1.0491 + 0.6259^+ X_1 + 0.3065\ X_2 + 0.2903\ X_3$	$R^2 = 0.3644^+$
Under N_3, $Y_2 = 12.1718 + 0.9683^+ X_1 - 0.1882\ X_2 - 0.0910\ X_3$	$R^2 = 0.8994^+$
Under N_4, $Y_2 = 31.5864^+ + 0.6123^+ X_1 - 0.1781\ X_2 - 0.4849\ X_3$	$R^2 = 0.8717^+$
Under P_1, $Y_2 = 20.6205 + 0.7767^+ X_1 - 0.3776\ X_2 - 0.3744\ X_3$	$R^2 = 0.7658^+$
Under P_2, $Y_2 = 25.8755^+ + 0.7129^+ X_1 - 0.4335^+ X_2 - 0.4284\ X_3$	$R^2 = 0.6726^+$
Under P_3, $Y_2 = 15.8831 + 1.7795^+ X_1 - 0.1769\ X_2 - 0.2838\ X_3$	$R^2 = 0.8537^+$
Under P_4, $Y_2 = 14.4084 + 1.8048^+ X_1 - 0.1705\ X_2 - 0.1847\ X_3$	$R^2 = 0.7459^+$

X_1 = Wind velocity; X_2 = Relative humidity; X_3 = Atmospheric temperature; Y_2 = Drift loss; + Significant at 5% level
N_1 = 3.97 mm x 2.38 mm; P_1 = 1.2 KSC
N_2 = 4.76 mm x 2.38 mm; P_2 = 2.5 KSC
N_3 = 5.56 mm x 3.17 mm; P_3 = 3.5 KSC
N_4 = 6.35 mm x 3.17 mm; P_4 = 4.0 KSC



SP = SPRINKLER HEAD

Fig.1 Layout of Catch Cans-Grid Net Work

From the study, it is concluded that among the different climatic factors, wind velocity is having consistant and positive influence over the drift loss while the contribution of relative humidity and temperature is negligible. Hence it is advisable not to operate the sprinklers during periods of high wind velocities. The ideal choice is to run the system at low wind periods.

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