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Effect of Wind Velocity on Distribution Efficiency From Twin Nozzle Sprinklers

M. C. Agarwal and S. Agarwal

Department of Soil, Haryana Agricultural University, Hissar

ABSTRACT

Amongst the various climatic conditions which have marked effect in sprinkler irrigation, wind is the most important one as it greatly influences the uniformity of coverage by distorting the pattern. Studies were conducted to determine the effect of varying wind conditions and different spacing combinanations on distribution efficiency. It was found out that spacing combinations of laterals and sprinklers at 18·3 × 12·2 meter gave the highest distribution efficiency under wind velocity varying from 3·38 to 15·45 km per hour. The best distribution was obtained at wind velocity of 5·68 km/h and the distribution was poor at wind velocity higher and below than this. *(Received on April 4, 1977)*

INTRODUCTION

SPRINKLER IRRIGATION is gaining popularity in Indian agriculture. For obtaining maximum returns at minimum cost, its proper design and operation according to agro-climatic conditions of the locality is important.

The distribution of water over an area is acknowledged to be an important aspect of sprinkler irrigation system design. The water distribution from the sprinkler depends upon the operating conditions existing at the time of its operation. The significant operating conditions at any time for a particular type and size of equipment is wind velocity and direction, nozzle pressure and sprinkler spacing (Branscheid and Hart, 1968).

The rotating sprinklers provide precipitation over a circular area and the depth of water applied to the area surrounding the sprinkler decreases as the distance from the sprinkler increases. However, proper spacing of sprinklers and adequate overlapping can provide reasonably uniform application over the area.

The wind moves the water droplets and disturbs the distribution pattern since without wind the largest drops usually land farthest from the sprinkler but wind carries the smallest drops farthest and the largest drops nearest (Pillsbury, 1968).

MATERIALS AND METHODS

A small portable sprinkler irrigation unit consisting of a centrifugal pump of 5 cm × 5 cm size driven with 3·5 horse power electric motor was used. The 5 cm dia aluminium pipes were used as mains and laterals. The laterals were placed at normal to wind direction. Slowly revolving impact driven, rotating head, rain spray twin nozzles sprinkler

having nozzles of 3 mm and 6 mm diameter mounted on one meter high risers were used. A pressure gauge was fitted to note the pressure. The plastic containers were placed at 3·05 m grid system to a distance of 12·2 m on all sides of the sprinkler to determine the distribution pattern from a single sprinkler (Davis, 1966).

Distribution tests were conducted at different dates when the wind velocities were 3·38, 15·45, 5·58, 9·09, 10·4 km/h and gauge pressure was 2·95, 3·09, 2·95 and 3·09 kg/sq cm, respectively. The general direction of wind velocity in the area was either WSW or ENE. It is assumed that during the test the wind velocity and direction did not change significantly.

RESULTS AND DISCUSSION

The distribution pattern (water collected in each container) came out to be as shown in Fig. 1 during a test for one hour when the wind velocity was 6·9 km/h and the gauge pressure was 2·95 kg/sq. cm.

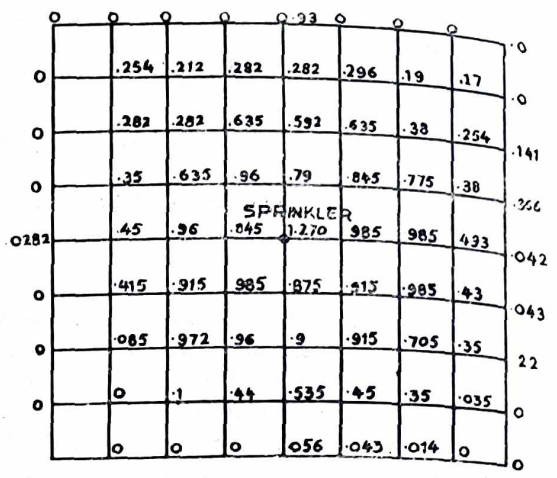

Fig. 1. Distribution pattern from single nozzle sprinkler.

From these tests the distribution was superimposed from all sides assuming sprinklers to be at a distance of 12·2 m, 18·3 m and 24·4 m, apart and curves were drawn for distance from the sprinkler V/s depth of water applied. The resulting curves came out to be of the type as shown in Fig. 2(a). The graph clearly showed that the resulting distribution curve was approaching parallel to the

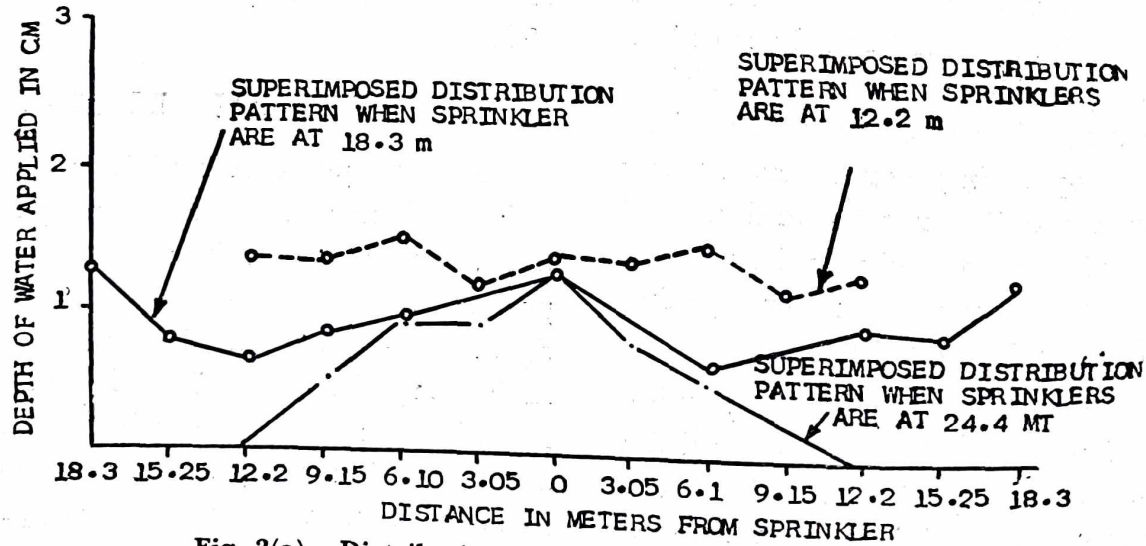

Fig. 2(a). Distribution pattern resulting from sprinklers spacing on lateral at 12.2, 18.3 and 24.4 metre.

scissa when the superimposition was ne keeping the sprinklers at 12·2 m art, which indicates that the distribu- on is more uniform when the sprinklers e set at a distance of 12·2 m from ach other.

Similarly the distribution was super- mposed from all sides assuming laterals o be at a distance of 12·2, 18·3, 24·4 m nd curves were drawn with distance rom the sprinkler to the depth of water pplied. The resulting curves came out

The similar curves were drawn for all the tests and it was found that the sprinkler set at 12·2 m apart and laterals set at 18·3 m apart give the best distribu- tion of water for twin nozzle sprinklers at the wind velocities ranging from 3·38 to 15·45 km/h.

Christiansen (1942) developed the uniformity coefficient (Cu) to serve as a numerical index of the uniformity secured with a system of overlapping rotating sprinkler as under:

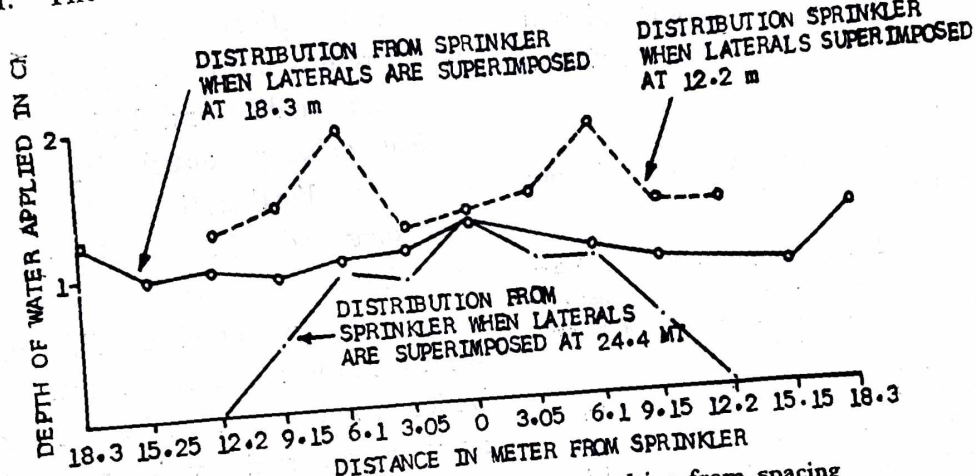

Fig. 2(b). Distribution pattern resulting from spacing of laterals at 12.2, 18.3 and 24.4 metre.

to be of the type as shown in Fig. 2(b). The graph showed that the resulting distribution curves were approaching to be parallel to abscissa when the super- imposition was done keeping the laterals at 18·3 m apart which clearly indicate that the distribution is more uniform when the laterals are set at a distance of 18·3 m from each other.

In both the cases the resulting curves have not come absolute parallel to the abscissa, since the absolute uniformity can never be achieved. Pillsbury (1968) has also made similar observations.

$$Cu = 100\ (I - X/N)$$

wherein

Cu = Uniformity coefficient.

X = Average numerical deviation in depth of water stored from average depth stored during irrigation.

N = Average depth of water stored in the root zone during irriga- tion.

The distribution efficiency of the sprinkler by superimposition was deter- mined by keeping the laterals at 18·3 m

and sprinkler at 12·2 m apart for various tests (Fig. 3).

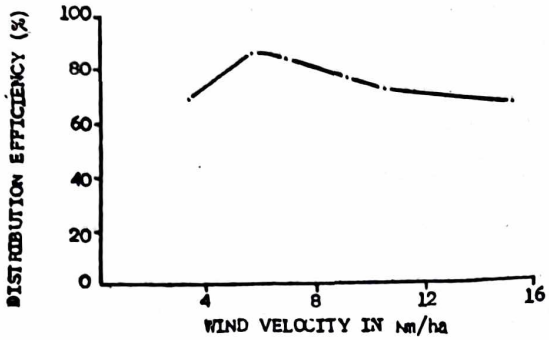

Fig. 3. Distribution efficiency vs wind velocity for twin nozzle sprinkler.

The data in Table 1 indicated that the distribution efficiency was maximum

TABLE 1

Effect of wind velocity on distribution efficiency from twin nozzle sprinkler.

Sr. No.	*Date of test*	*Average wind velocity (km/h)*	*Gauge pressure in kg/sq.cm during the test*	*Distribution efficiency in per cent*
1	5.8.1969	3.38	2.95	69.5
2	28.8.1969	15.45	3.09	65.7
3	1.9.1969	5.69	2.95	86.2
4	18.9.1969	9.09	3.09	76.0
5	19.9.1969	6.92	2.95	83.3
6	23.9.1969	10.46	3.09	71.2

when the wind velocity was (3·5km/h), 5·67 km/h and it decreased with the increase and decrease of wind velocity. The decrease in distribution efficiency with increase in wind velocity above 5·67 km/h was well-understood but the reduction in distribution efficiency when wind velocity tended to be smaller than 5·67 km/h is interesting to observe. Although similar observation has been made by Branscheid and Hart (1968) but they did not put forth any explanation for this. However, in the opinion of the authors, the possible explanation for the decrease in distribution efficiency at low wind velocity was perhaps due to the less break-up of water particles and decrease of distribution efficiency due to greater wind velocity was due to the shifting of pattern to one side by the wind current.

From the foregoing discussion, it is evident that for a particular sprinkler system a critical wind velocity exists which results in best distribution and at velocities smaller and higher than the critical velocity, distribution efficiency decreases. Further, the studies conducted also suggested that as long as the operating pressure was not altered, the spacing need not be changed for varying wind conditions. However, better distribution can be achieved by using higher risers as reported by Wiersma (1955).

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