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Performance Evaluation of Sprinkler Irrigation System in Ganderbal District J&K State

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Authors' contributions

This work was carried out in collaboration between both authors. Author NURR designed the study, performed the statistical analysis, wrote the protocol and first draft of the manuscript. Author MAB managed the analyses of the study and literature searches. Both authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Field experiments were carried at Krishi Vigyan Kendra (KVK), Shuhama (Jammu and Kashmir) to study the performance evaluation of sprinkler system. The climatic conditions of previous years were obtained and were taken into consideration before the starting of the experiment. The climatic conditions recorded for the experiment were wind speed and wind direction. The micro sprinkler arrangement was made of two types – point arrangement and linear arrangement. The volume of water was collected in water containers, systematically leveled on the ground surface and placed 0.75 x 0.75 m apart. The volume of water was measured by the aid of measuring cylinder. The water flow pressure for the experiment was kept 1.5 Kg/cm^2 and 2.0 Kg/cm^2. The pressure was measured by a pressure gauge. The riser height was kept 0.75 m and 1 m respectively. The data revealed that uniformity coefficient varied from 82.83 to 88.7 percent in point arrangement of micro sprinklers, whereas uniformity coefficient varied from 86.10 to 91.76 percent in case of the linear arrangement of sprinklers. Experiments revealed that the change in riser height and operating pressure affected the uniformity coefficient significantly. Data also revealed that wind velocity was

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found to be low in the morning as compared to evening. However, wind velocity didn't show a significant effect on uniformity coefficient as wind velocity was found to be very low in the experimental area.

Keywords: Sprinkler irrigation; micro irrigation; performance; evaluation; uniformity coefficient; Kashmir.

1. INTRODUCTION

Water is the most vital natural resources for the survival of human being. There is same amount of water on earth today as there was when the earth was formed. However, with increase in human and cattle population, the demand for food fiber and fodder has been increasing. As a result, water resources are progressively getting exhausted and competition for available water between agriculture, the domestic and industrial sectors is increasing day by day [1]. Irrigation is a crucial input for the development of agriculture and the importance of irrigation statistics in modernization and revolutionization of agriculture can hardly be underestimated [2].

In the global scenario, the demand for water has been on the increase from all fronts, whether be it agriculture, industry or municipal use. To increase the production of crops for feeding the world population of about six billion with dwindling water resources is a challenge [3]. The conventional method of irrigation has not been as efficient in the use of water thus resulting in excessive wastage besides creation of problems in many regions through waterlogging and salinity. Unscientific use of water apart from wastage has an injurious effect on soil health [4]. Therefore, judicious use of water is vital to achieve higher productivity in a sustainable manner. The modern systems of irrigation like drip, sprinkler coupled with other improved water management practices enhance the water use efficiency and productivity [5]. The method of applying water above the ground surface somewhat resembling rainfall is known as a sprinkler system.

The basic aim of the sprinkler irrigation method is to apply water uniformly as possible to the root zone. Sprinkling, as a method, has been used for many years in different parts of the world for the irrigation of nurseries, vegetables and special crops [6]. They are placed on a relatively close rectangular or triangular spacings for the maximum overlap to irrigate potatoes, carrots, leafy vegetables, groundnuts and other densely planted field crops. The sprinkler irrigation method can be used on lands with irregular topography and is well adapted to light application of water for purposes of seedbed preparation, seed germination and transplanting of seedlings [7]. Irrigation by sprinkling can be adapted to all types of soils. The quickness with which the equipment can be transported and installed, as well as the possibility of irrigating without any special land preparation, are features which make irrigation by sprinkling attractive for this purpose [8-15].

In view of the fact that micro-irrigation systems including sprinkler have not been popularized in Jammu and Kashmir and not enough work has been done on the performance evaluation of Sprinkler system in Jammu and Kashmir. Given the importance of the sprinkler irrigation system and its popularity, the present study was taken to study the feasibility of the sprinkler system and effect of various operating parameters on the system performance.

2. MATERIALS AND METHODS

The experiment was conducted at the Krishi Vigyan Kendra (KVK), Shuhama which is situated in district Ganderbal of J&K state. The experiment site is located at an altitude of 1730 m above the sea level and the region falls in the temperate zone. The experimental site has a longitude of 34.04 degree North and latitude of 74 degree south.

The micro sprinkler components manufactured by Jain irrigations were used for the experiment along with water containers. The main features of the given system are as under.

Crop	: Vegetables
Area	: 40 x 85 m
Spacing	: 4.5 x 4.5 m (sprinkler)
Water source	: Water tank
Mains	: PVC pipe 75 mm x 4 kg/cm^2
Sub-mains	: PVC pipe 63 x 4 kg/cm^2
Laterals	: Polytube 16 mm.
Discharge	: 69 liters/hour

The layout of Micro Sprinkler Irrigation System Project at 'KVK' Shuhama is illustrated in Fig. 1.

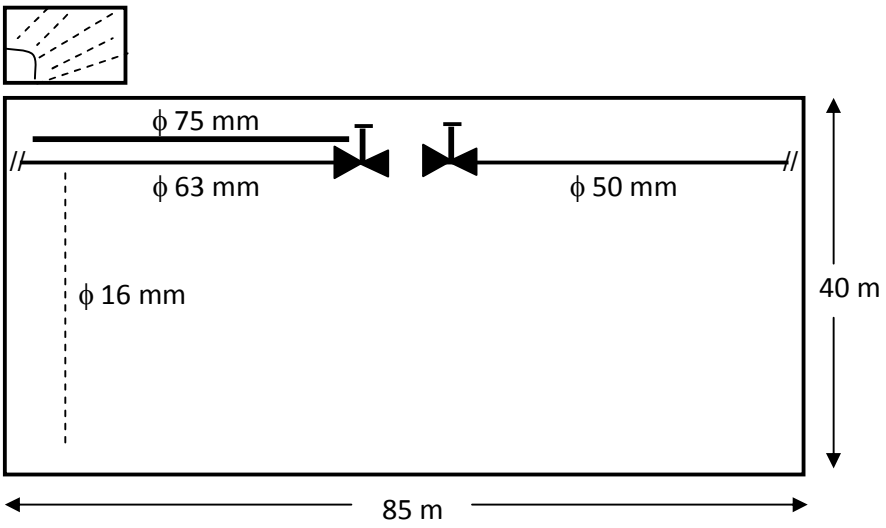

Fig. 1. Layout of micro sprinkler Irrigation system project at 'KVK' Ganderbal

Water containers were used for collecting the discharge from the micro sprinkler in such a way that loss of water because of splashing was avoided. The uniformity coefficient was calculated on two arrangements namely, linear arrangement (Fig. 2) and point arrangement (Fig. 3). There were 34 water containers used in point arrangement where as 53 water containers were used in linear arrangement. The water containers were placed in 0.75 m x 0.75 m grid. The uniformity coefficients were calculated with the help of Christiansen (1942) formula,

$$c_u = 100[1 - \frac{\sum x}{mn}]$$

A pressure gauge, having a range of 0-7 kg/cm^2, was used to measure the pressure developed in the lateral line. The system was run at two different pressures, 1.5 and 2 kg/cm^2. Uniformity coefficient was also calculated on two different riser heights of 0.75 m and 1 m.

Different agro climatic factors were considered during the experiment. The different parameters recorded and analyzed were wind speed, wind direction and other weather conditions. These data were obtained from the Division of Agronomy, SKUAST-K.

3. RESULTS

3.1 Effect of Riser Height and Operating Pressure

There was a significant effect of riser height and operating pressure on the uniformity coefficient. Uniformity Coefficient increased with the decrease of riser height (from 1 to 0.75 m) and increase of operating pressure (from 1.5 to 2 kg/cm^2). The decrease in uniformity coefficient with the increase of riser height may be due to evaporation losses and drift losses. Higher uniformity was achieved at higher pressure (2 kg/cm^2).

3.2 Effect of Wind Velocity

A unique problem for sprinkler systems is that the water application pattern is susceptible to distortion by the wind. While wind speed and direction are not controlled variables, their effect on irrigation uniformity is significant. However, in present case studies, it was found that the wind velocity remains nearly uniform. The wind velocity data of previous three years were studied and it was found that wind velocity in this particular area (Ganderbal) was found to be nearly uniform and the wind velocity was found to be very low (except in some special weather cases). With the increase in wind velocity, uniformity coefficient decreased. However, it was not significant in this particular area as the wind velocity was very low (Figs. 4, 5 and 6).

Table 1. Process variables and their levels

Variable name	Levels	
Pressure (kg/cm^2)	1.5	2.0
Riser height (m)	1	0.75
Wind velocity	Morning	Evening

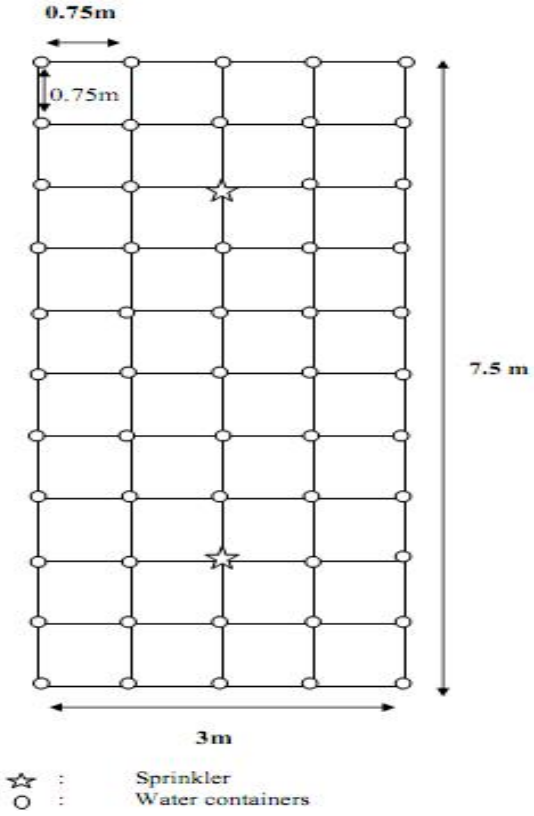

Fig. 2. Layout of linear arrangement of micro sprinkler

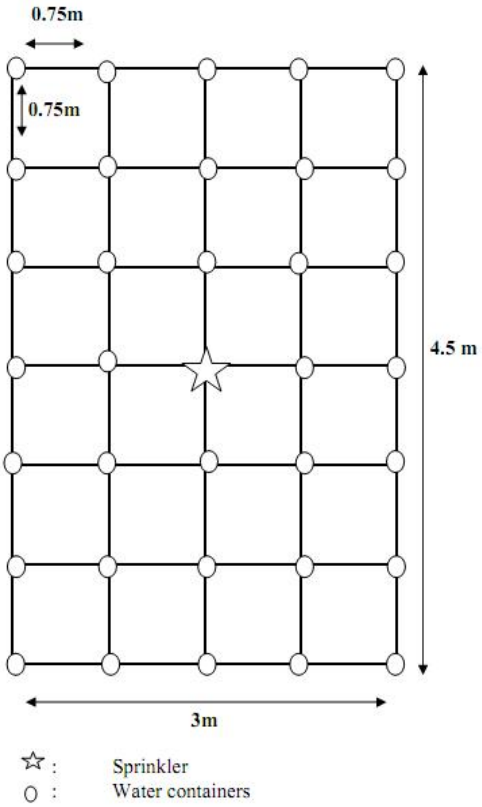

Fig. 3. Layout of point arrangement of micro sprinkler

Table 2. Experimental findings in point arrangement

Expt. no	Pressure (kg/cm^2)	Riser height (m)	Wind time	Wind speed (km/hr)	Uniformity coefficienty (%)
1	1.5	1	M	1.5	84.49
2	1.5	1	E	2.6	82.83
3	1.5	0.75	M	1.6	86.40
4	1.5	0.75	E	2.0	86.20
5	2.0	1	M	1.6	87.16
6	2.0	1	E	2.0	86.40
7	2.0	0.75	M	1.5	88.70
8	2.0	0.75	E	2.6	87.80

Table 3. Experimental findings in linear arrangement

Expt. no	Pressure (kg/cm^2)	Riser height (m)	Wind time	Wind speed (km/hr)	Uniformity coefficienty (%)
1	1.5	1	M	1.5	87.94
2	1.5	1	E	2.6	86.10
3	1.5	0.75	M	1.6	89.74
4	1.5	0.75	E	2.0	88.15
5	2.0	1	M	1.6	90.45
6	2.0	1	E	2.0	88.98
7	2.0	0.75	M	1.5	91.76
8	2.0	0.75	E	2.6	91.02

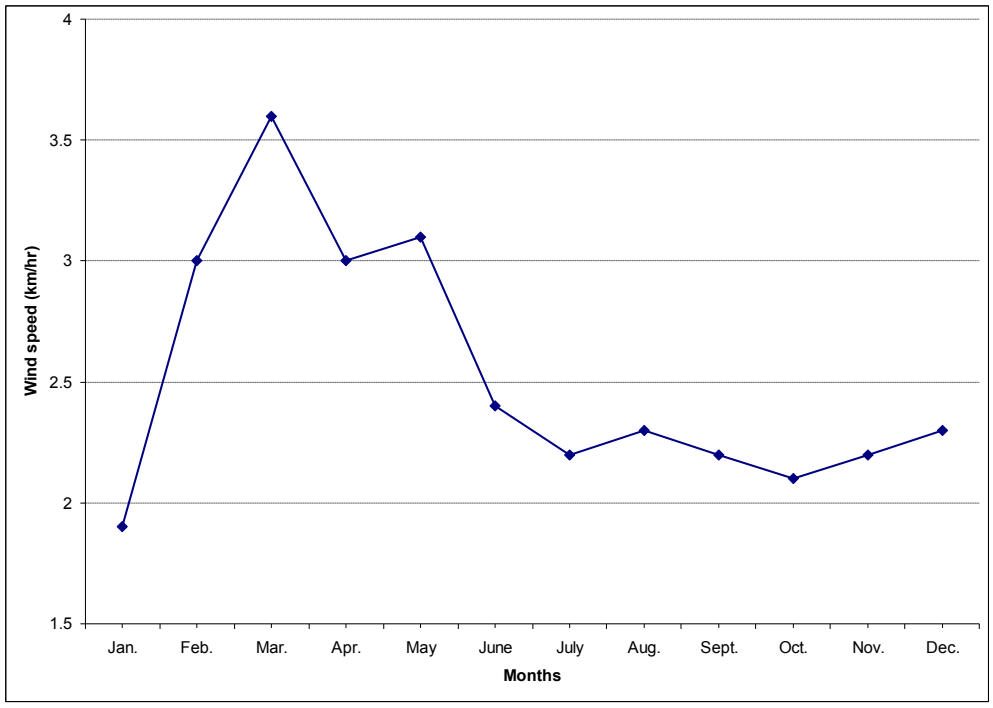

Fig. 4. Monthly average wind speed (km/hr) in district Ganderbal during 2014

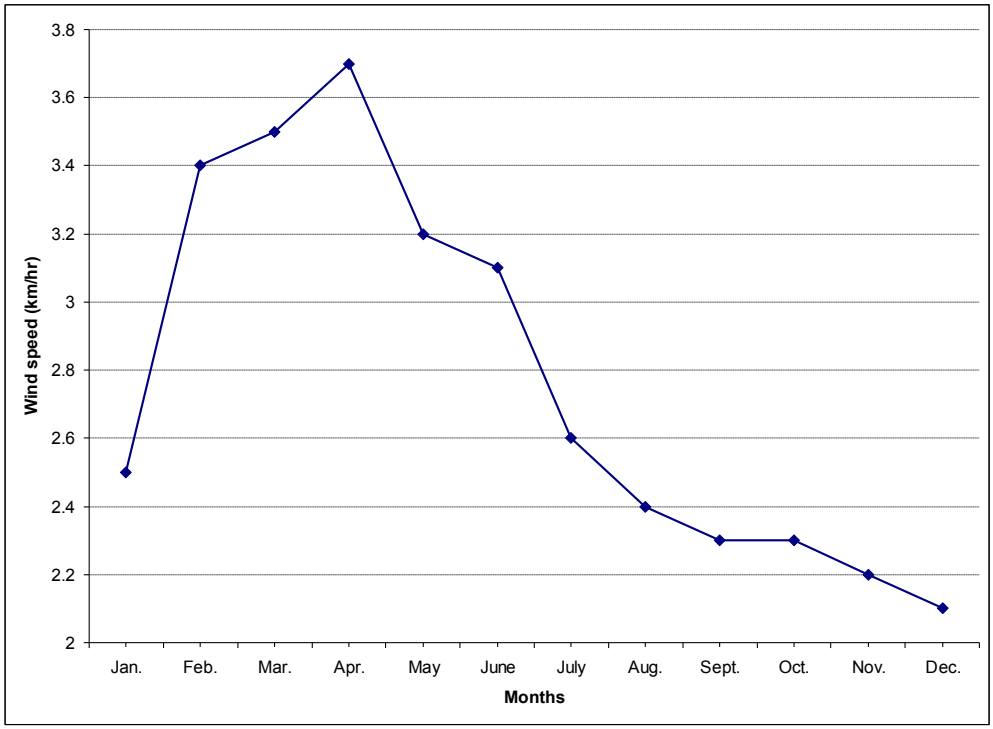

Fig. 5. Monthly average wind speed (km/hr) in district Ganderbal during 2015

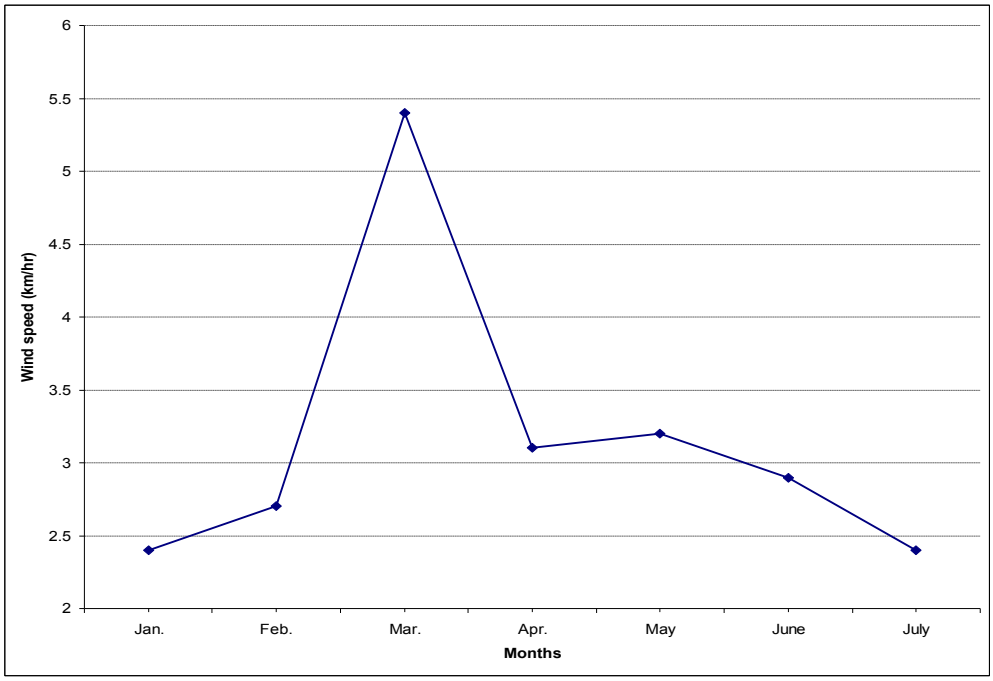

Fig. 6. Monthly average wind speed (km/hr) in district Ganderbal during 2016.The month of March has shown a steep increase in curve because of wind speed recorded on 12th of March was 63.6 km/hr

4. DISCUSSION

From the present studies, it was concluded that the uniformity coefficient obtained from field data was found to be 82.83 and 88.7 percent as minimum and maximum in point arrangement of micro sprinklers, whereas it varied from 86.10 and 91.76 percent in case of the linear arrangement of sprinklers.

Wind velocity during the experiment varied from 1.5 to 2.6 km/hr. Under these conditions, the effect of wind velocity on uniformity coefficient was not significant. Under present circumstances, the system can be run anytime.

Uniformity coefficient increased with the increase in operating pressure and decreased with the increase in riser height. The decrease of uniformity coefficient with the increase in riser height may be due to evaporation losses and drift losses.

5. CONCLUSION

Uniformity coefficients were calculated from the field data and were found to be 82.83 and 88.7 per cent as minimum and maximum in point arrangement of micro sprinklers and 86.10 and 91.76 per cent respectively, in case of linear arrangement.

There was a significant effect of riser height and operating pressure on the uniformity coefficient. Uniformity Coefficient increased with the decrease of riser height (from 1 to 0.75 m) and increase of operating pressure (from 1.5 to 2 kg/cm^2). The decrease in uniformity coefficient with the increase of riser height may be due to evaporation losses and drift losses. Higher uniformity was achieved at higher pressure (2 kg/cm^2).

A unique problem for sprinkler systems is that the water application pattern is susceptible to distortion by the wind. While wind speed and direction are not controlled variables, their effect on irrigation uniformity is significant. However, in present case studies, it was found that the wind velocity remained nearly uniform.

With the increase in wind velocity, uniformity coefficient decreased. However, it was not significant in this particular area as the wind velocity was very low.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Available:http://www.fao.org/docrep/016/ap106e/ap106e.pdf
2. Qazi. Systematic Geography of Jammu and Kashmir. 2010;Chapter 1:3-4.
3. Available:http://science.sciencemag.org/content/sci/327/5967/812.full.pdf?sid=d8e9be99-b991-4ccc-9a98-3a3c3df00bf8
4. Bhattacharya AK. Integrated Water Management. 2007;Chapter 1:7-8.
5. Dinesh K. Food security and sustainable agriculture in India. The Water Management Challenge. 2009;17-18.
6. Sharma, Subedar. Integrated water management irrigation methods. IARI, New Delhi. 2010;33-34.
7. Ashraf Mustafa. Evaluation of the center pivot and linear move sprinkler irrigation systems under Sudan conditions. 2000; 18.
8. Bean AGM. Water distribution by irrigation sprinklers. Journal of Agricultural Engineering Research. 1965;10(4):314-321.
9. Benani, Hore. A new sprinkler distribution coefficient transitions of the ASAE. 1964;7(1):157-159.
10. Christiansen JE. The uniformity of application of water by sprinkler system. Agric. Engg. 1942;22(33):89-92.
11. David K. Estimating sprinkler distribution pattern using linear regression. Trans. ASAE. 1978;21(4):682-686.
12. Demirel K, Sener S. Performance of sprinkler irrigation systems at different pressures and under varying wind speed conditions in landscape areas. Philippine Agricultural Scientist. 2009;92(3):308-314.
13. Dhan D, Imtiyaz M. Performance evaluation of micro-sprinkler system under different arrangements. Society for Development in Agriculture and Technology. 2009;4(2):268.
14. Pair CH. Water distribution under sprinkler irrigation transactions of the ASAE. 1968; 11(5):648-651.
15. Singh SR, Lal R. Uniformity coefficient of sprinkler irrigation. Paper presented at the 8th Annual Conference of ASAE, Ludhiana; 1970.

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