www.ThePharmaJournal.com

The Pharma Innovation

**ISSN (E): 2277- 7695**
**ISSN (P): 2349-8242**
**NAAS Rating: 5.23**
TPI 2022; SP-11(1): 485-489

www.thepharmajournal.com
Received: 16-11-2021
Accepted: 18-12-2021

**Dr. BL Sinha**
DKS College of Agriculture and Research Station, Indira Gandhi Krishi Vishwavidyalaya Alesure, Bhatapara, Balaudabazar, Chhattisgarh, India

**Corresponding Author**
**Dr. BL Sinha**
DKS College of Agriculture and Research Station, Indira Gandhi Krishi Vishwavidyalaya Alesure, Bhatapara, Balaudabazar, Chhattisgarh, India

# A study on performance evaluation of sprinkler irrigation system at farmers field in Chhattisgarh plain

## Dr. BL Sinha

**Abstract**
Sprinkler irrigation has proved to be an efficient irrigation system compared to conventional methods of irrigation although the initial cost of installation is high. It is crucial to ascertain the performance for minimizing water losses and providing better uniformity. The study was undertaken to evaluate the efficient use of sprinkler irrigation system by farmers. Sixty farmers of 12 villages of three blocks of Mungeli district of Chhattisgarh were randomly selected among the farmers who were given sprinkler irrigation system on subsidy basis. In this study, portable sprinkler system was evaluated based on its hydraulic performance at farmer's field of Mungeli district of Chhattisgarh plain. A portable sprinkler irrigation system was installed to evaluate of the performance of the sprinkler system in three patterns namely:, uniformity coefficient distribution efficiency and application efficiency. Uniformity measurements were performed using catch can. Test was carried out to determine the performance of portable sprinkler irrigation systems under field conditions. The results of the field performance revealed that the average value uniformity coefficient, distribution uniformity and application efficiency for sprinkler irrigation systems in the study area were observed as 78.30%, 73.12% and 74.41%, respectively indicating satisfactory performance of the sprinkler system. Overall performance parameters of sprinkler irrigation system were in the recommended level. Hence there is potential for the adoption of sprinkler irrigation technology which could increase the yield and the farmer's income by increasing the extent of cultivation with the available water resource.

**Keywords:** sprinkler irrigation, application efficiency, uniformity coefficient, distribution efficient

## Introduction

Efficient use of available irrigation water is essential for increasing agricultural productivity for the alarming Indian population. As the population of India is increasing day by day, the pressure on agriculture is increasing in the same way. For an efficient irrigation, water has to be uniformly applied to the crop field. 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 (Nasir and Muddasir, 2017) [7]. 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.

The global climate change and its attendant effect on scarce water resources have further reduced the amount of water available for agriculture. Under this circumstance, the use of pressurized irrigation systems can be an option of enhancing the efficiency of water consumption. Pressurized irrigation methods usually have better water application uniformity than surface irrigation methods, which are more easily managed and have low labour requirement. Sprinkler irrigation system is one of pressurized irrigation systems in which water is sprayed in to the air and allowed to fall on the ground surface somewhat resembling rainfall. The spray is developed by the flow of water under pressure through small orifices or nozzles. The pressure is suitably obtained by pumping. The amount of irrigation water required to refill the crop root zone can be applied nearly uniform at the rate to suite the infiltration rate of the soil, there by obtaining efficient irrigation.

Sprinkler irrigation system is being widely used especially in those areas where land topography in not favorable for traditional irrigation. Although it requires high initial investment as compared to the conventional methods, the sprinkler system is highly adaptable. When highly pressurized water is passed through sprinklers, the water gets discharged in form of small droplets from the aperture of sprinkler. Sandy soil with high infiltration rate is highly suitable for sprinkler system however it is also adaptable to most of the soils. Average rate of water application should be less than the basic infiltration rate of the soil to avoid water ponding over the soil surface and also to check the formation of overland flow in the field.

Sprinklers can be a good investment when properly designed, installed, maintained and managed. Sprinklers apply water more efficiently and uniformly than typical surface irrigation systems, thus they produce more yields for each quantity applied per unit area (Ahaneku, 2010) [3]. Critical evaluation of the sprinkler irrigation system is very important in order to identify whether the system is operating at the required performance level and then suggest improvements to the operation of the system. Irrigation performance assessment is an essential component of the general performance of the sugar estate. Moreover, in-field performance evaluation indicates both the location and magnitude of water loses that are occurring, and then determining how to improve the irrigation system and/or its operation (Al-Ghobari, 2006) [1]. It also assists the system management or decision makers in determining whether performance is satisfactory and, if not, which corrective actions need to be taken in order to improve the situation (Patil, 2012) [8]. In view the above facts, present research work was undertaken to evaluate the performance of sprinkler irrigation system for wheat crop in Mungeli district of Chhattisgarh Plain.

## Material and Methods

The present study was conducted in newly formed Mungeli district of Chhattisgarh plain which is situated between 22.06$^0$ N latitude and 81.68$^0$E longitude in the year of 2016-17. The average altitude above sea level is 287 m. Here farmers are using all possible modern technology to enhance their crop yield. For collecting information on sprinkler irrigation system technologies, the field surveys were conducted in the rural areas of Mungeli belonging to the different agro-climatic zones of Chhattisgarh state. The study was conducted at Different sprinkler irrigation of Chhattisgarh on the basis of agro-climatic zone. Out of 27 districts of Chhattisgarh, one district Mungeli was randomly selected. In which three blocks namely Mungeli , Pathariya and Lormi of the district were selected. Four villages of each selected block were identified for the purpose of study. The average temperatures of irrigation season within the plant growth period in the district according to the long terms records range from 7.8 and 35 ˚C. The maximum and minimum relative humidity during the crop period was 19 to 96% respectively. Both ground water and surface water sources are used in the region. The surface water source is canals and stream. Ground water sources mostly used in tubes wells for this area.

First of all, examinations and observations in sprinkler irrigation system were conducted in farmer’s field of the district. The present study was planned to conduct study on each five farmers in 12 different-villages of three blocks (Mungeli, Lormi and Pathariya) of Mungeli district when considered their water resources and pumping units. The study was conducted on 60 sprinkler systems at farmer’s field for examining. The technical information related to the power resource, pump type, main and lateral lines and sprinkler in the portable sprinkler systems; and correlated operational and technical data in the planned sprinkler systems such as main line length, lateral length, number and spacing of lateral lines, number and spacing of sprinkler**,** average operation pressure and flow rate, lateral operating duration and number of irrigations were collected.

**Layout and Orientation of Catch Cans:** Cans of identical measurement was used during test and they had diameter and height of 100 mm and 120 mm respectively, with a volume of about 0.750 liter. Catch-cans were arranged in a rectangular grid of 3X3 m when the test of sprinkler system was in between laterals.

**Data Collection:** All necessary primary data required to complete this research study, i.e. to evaluate the hydraulic performance of sprinkler system was collected through a study which was conducted over the representative selected fields of farmers in the study area. Additionally, Secondary data’s such as Climate data of representative meteorological stations and others were also collected from the nearest station to the study area.

**Data Analysis:** The data obtained from experimental trials from both irrigation systems were used to determine different hydraulic performance indicators for evaluating and comparing the existing combined operational systems. The parameters that were used to evaluate:

### Hydraulic Performance Indicators

**Coefficient of Uniformity:** One of the first and most common quantitative measures of uniformity is the Christiansen Uniformity coefficient (CU). This was developed for evaluating sprinkler systems in 1942, and is still the most widely used and accepted measure for uniformity. It is expressed by the equation developed by Christiansen (1942) [2]

$$\mathrm{CU} = 1 - \frac{\Sigma \mathrm{X}}{\mathrm{m.n}} \times 100 \quad \text{.... (1)}$$

Where,

CU= Uniformity coefficient,%

Σx = sum of numerical deviation of individual observation from the mean application rate of water, m.

m = mean of all observation, that is average application tare of water, mm

n = total number of observations.

A set of recommendations for the minimum requirements on uniformity coefficient showed in Table 1 (Luxmini *et al*, 2015) [5].

**Table 1:** Uniformity classification of sprinkler irrigation system based on UC values

| S. No | Uniformity coefficient, UC (%) | Classification |
|---|---|---|
| 1 | Above 90% | Excellent |
| 2 | 90%-80% | Good |
| 3 | 80%-70% | Fair |
| 4 | 70-60% | Poor |
| 5 | Below 60% | Unacceptable |

**Distribution Uniformity:** The pattern efficiency (also known as distribution efficiency, DU) can be calculated after obtaining the total depths at each of the grid point. The minimum depth is calculated considering average of the lowest one fourth of the cans used in a particular test. Distribution efficiency > 87 excellent (calculation given appendix).Pattern efficiency is given by

$$DU = 100\frac{m4}{m} \quad \text{.... (2)}$$

Where,
DU = Distribution Uniformity,%
m = is the mean depth, and
m4 = is the mean depth of the lowest quarter of the observations.

The evaluated systems were classified according to the DU values, shown in Table 2 (Luxmini *et al*, 2015) [5].

**Table 2:** Uniformity classification of sprinkler irrigation system based on DUC values

| S. No | Distribution uniformity, DU (%) | Classification |
|---|---|---|
| 1 | >87 | Excellent |
| 2 | 75-87 | Good |
| 3 | 62-75 | Acceptable |
| 4 | <62 | Unacceptable |

**Application Efficiency:** Application efficiency (Ea) is normally defined as the ratio of the volume of irrigation water to the average volume of water delivered to the area. Ea is an important performance indicator for evaluation of irrigation systems. The water required in the root zone is assumed to be applied at the minimum flow rate and over the total irrigation time. Therefore, application efficiency can be expressed as,

$$Ea = \frac{\text{Minimun rate caught}}{\text{Avarage application rate}} \quad \text{.... (3)}$$

### Results and Discussion
In this section, the summarized results are presented in the form of tables and graphs with relevant interpretations and discussions.

### Uniformity Coefficient of Sprinkler Irrigation System
The uniformity coefficient for sprinkler method of irrigation was determined using Christianson's equation. Coefficient of uniformity computed for all representative farmers fields of different blocks of Mungeli district are presented in Table 3 and Figure 1 to 3.

**Table 3:** Performance Evaluation Parameters of Sprinkler Irrigation System

| Blocks | Villages | Uniformity coefficient | Distribution efficiency | Application efficiency |
|---|---|---|---|---|
| Mungeli | Banki | 82.0 | 75.0 | 86.40 |
| | Chalan | 69.5 | 61.5 | 77.33 |
| | Baluadi | 84.0 | 74.0 | 63.71 |
| | Ghuteli | 81.0 | 80.2 | 76.46 |
| Pathariya | Jareli | 83.0 | 61.7 | 71.56 |
| | Rohra kalan | 85.4 | 79.0 | 62.8 |
| | Badra | 69.4 | 83.7 | 83.36 |
| | Dhardei | 86.1 | 72.0 | 70.85 |
| Lormi | Barampur | 81.9 | 82.6 | 84.8 |
| | Lakhasar | 68.5 | 73.2 | 71.35 |
| | Dongariya | 68.9 | 73.0 | 79.93 |
| | Dholgi | 80.0 | 61.6 | 64.40 |

It is revealed that uniformity coefficient in all the villages of Muneli block was above 80 per cent and thus, can be considered as good (Luxmini *et al*, 2015) [5]. The high coefficient of uniformity recorded could be ascribed to the appropriate selection of the types of sprinklers, spacing, efficient functional pressures of the sprinkler and favorable weather conditions (Nasab *et al*., 2007) [6]. In one village Chalan, it was found to be 69.50% which is under category of poor one (Luxmini *et al*, 2015) [5]. Similarly uniformity coefficient in Badra village of Patharya block and Lakhasar and Dongariya of Lormi blocks were below the 70 percent and were 69.4, 68.5 and 68.9 percent, respectively which is under category of poor one. This may due to defective design, improper implementation and weak exploitation, the pressure in the system was inappropriate. In addition, poor care and maintenance of sprinkler system, mishandling the system, improper installation of system and leakage problem in the system are reasons.

Higher uniformity could have been achieved if there were no leakage losses but lower uniformity were observed from the coupling joints of the mains and the laterals. The losses invariably led to small pressure differential between the main and the laterals and hence a little less than normal pressure uniformity in the field. With the high coefficient of uniformity attained by the irrigation system, the irrigator will have to devote more time in perfecting the system's scheduling to achieve higher crop yield occurred with higher sprinkler uniformity in the study area (Li & Rao, 2004) [4].

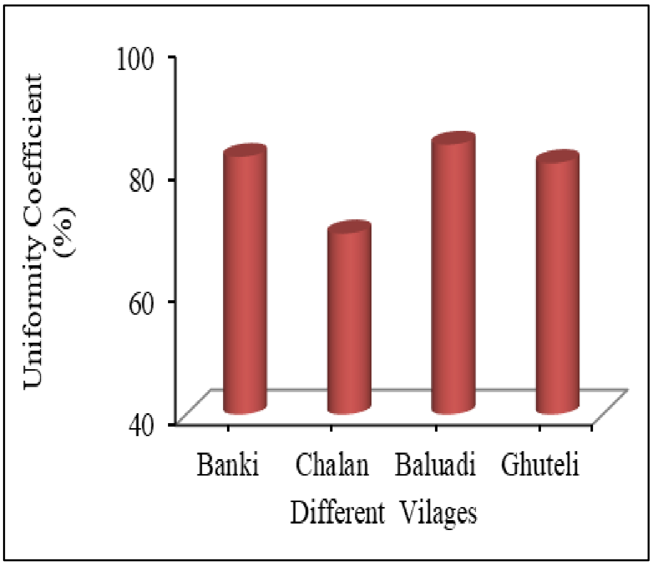


**Fig 1:** Uniformity coefficient in Mungeli Block

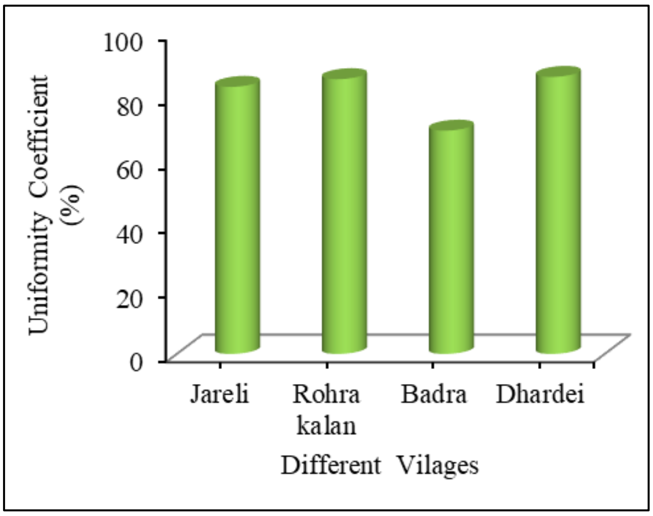


**Fig 2:** Uniformity coefficient in Pathariya block

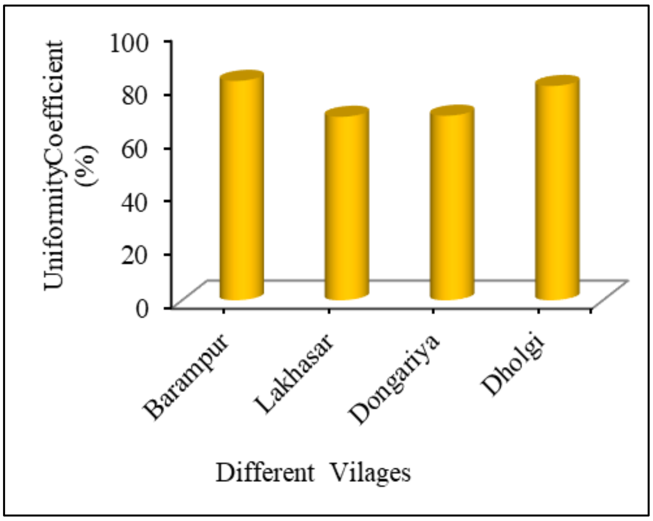


**Fig 3:** Uniformity coefficient in Lormi Block

**Distribution Efficiency (DU)**

The pattern efficiency also known as the distribution uniformity (DU) was also computed for the three sets of data. Sadler *et al.* (2000) [9] stated that the distribution uniformity gives an indication of the magnitude of the uneven distribution and can be defined as the percent of average application amount in the lowest quarter of the field. Table 3 presents that distribution efficiency varies from 61.5% to 80.20% at Mungeli block and it was 61.7 to 83.7% and 61.6 to 82.6 at Pathriya and Lormi block and shown in Fig 4 to 6. The results revealed that distribution efficiency was found to be 61.5, 61.7 and 61.6% at Chalan village of Mungeli block, Jareli village of Pathariya block and Dholgi village of Lormi block respectively which are unacceptable because below 62% (Luxmini *et al*, 2015) [5]. Main reason of low value of these parameters is low pressure and discharges of sprinklers. In addition, exploitation and poor management in most of these systems are additional reasons. Other problems of exploitation and management is using high number of sprinklers (simultaneously) by some farmers, leading to drop pressure in systems unacceptably. In addition to whole-round sprinklers, there are regulated sprinklers across the some fields; so that this reason also can be an additional reason of low distribution uniformity

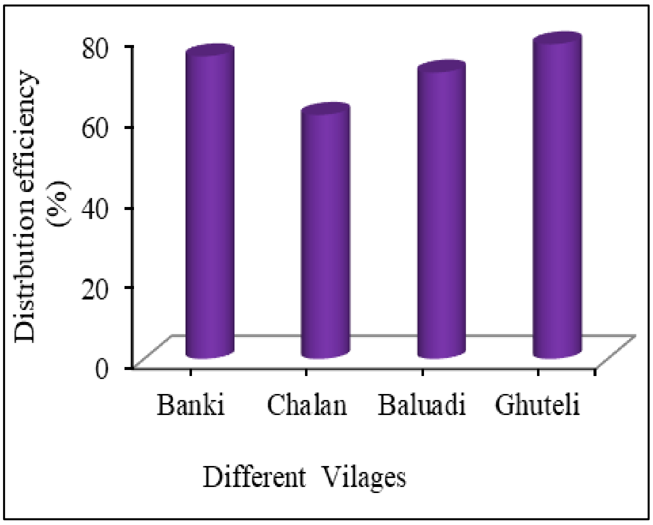


**Fig 4:** Distribution efficiency in Mungeli Block

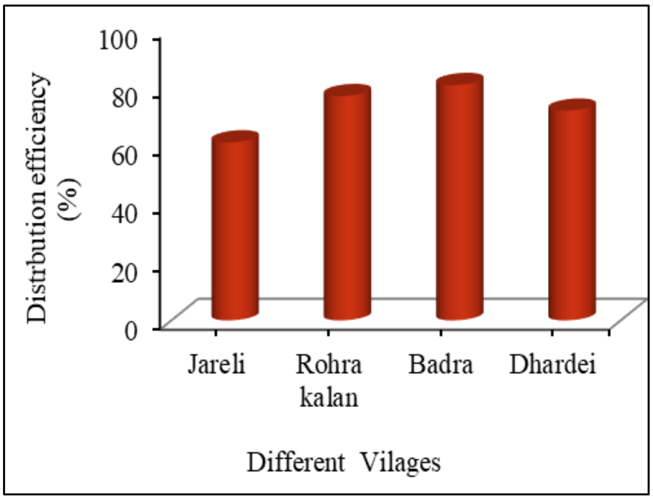


**Fig 5:** Distribution efficiency in Pathariya block

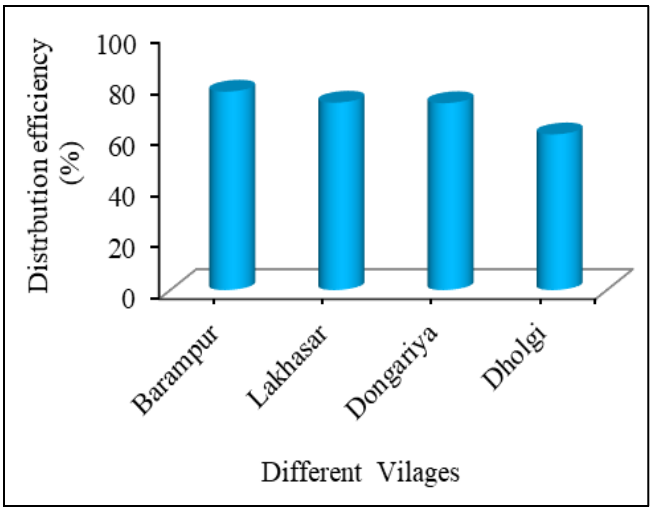


**Fig 6:** Distribution efficiency in Lormi block

**Application Efficiency**

Application efficiency is the ratio between the amount of water that leaves the sprinkler nozzle and the amount of water that eventually falls on the soils, infiltrates and is available for the plant. The application efficiency was calculated from the uniformity data. The purpose was to determine the loss of water as a result of evaporation and wind. The highest value of AE indicated that the average depth emitted from the sprinkler compared to the average depth recorded on the ground was similar. This was because of the wind speed in which it reached at peak during this time and the water applied to the crop was affected by drift losses

The results of computing application efficiency of three blocks are presented in Table 3 and shown Fig 7 - 9. It was observed that the application efficiency seems of acceptable to good level. For sprinkler irrigation the recommended minimum design application efficiency is 70%. The highest application efficiency of 86.40, 84.80 83.36% was observed in Mungeli, Lormi and Pathariya block respectively. It was also observed that application efficiency was below the recommended level at Belaudi (63.71%) village of Mungeli, Rohra Kalan (62.80%) of Pathariya block and Dholgi (64.40%) of Lormi block. Main reason of low value of the parameter is low pressure and discharges of sprinklers. In addition, exploitation and poor management in most of these systems are additional reasons.

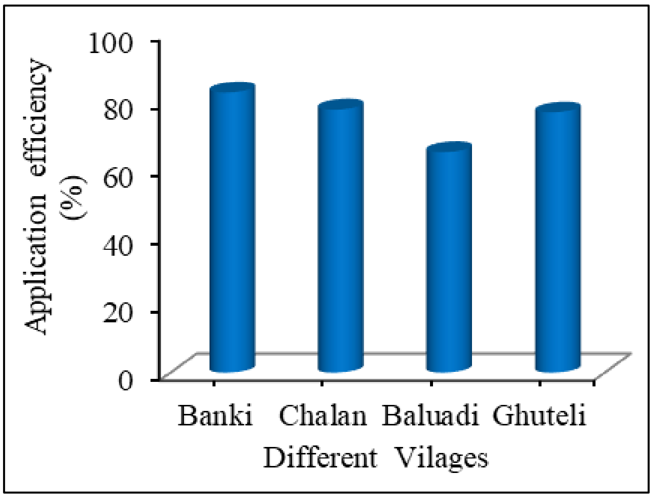


**Fig 7:** Application efficiency in Mungeli Block

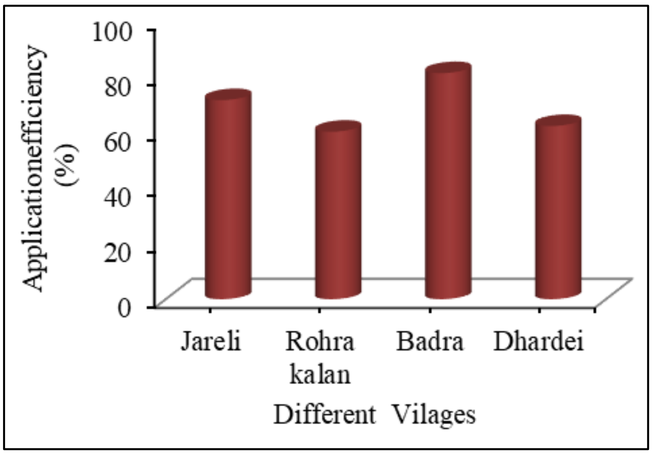


**Fig 8:** Application efficiency in Pathariya block

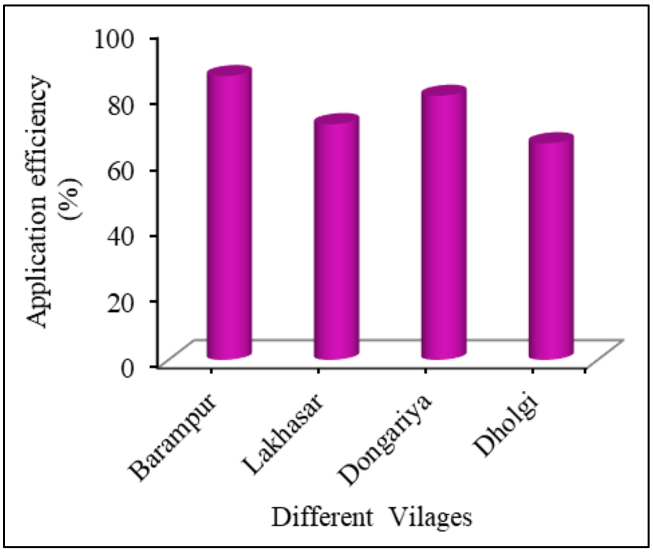


**Fig 9:** Application efficiency in Lormi block

## Conclusion

Based on the observations, it can be concluded that the use of sprinkler irrigation technologies resulted in a significant improvement in yield of wheat, over the conventional methods of irrigation. The values of Christiansen's uniformity coefficient, distribution uniformity and application efficiency were ranges between 65.5 to 86.10%, 61.5 to 83.70% and 62.80 to 86.40.9%, respectively. All the parameters were in acceptable limit except some fields (3 to 4). They were in below acceptable limit due not proper maintenance of sprinkler system and rotation speed. This is confirming that the overall performance parameters of sprinkler irrigation system were in the recommended level. It implies that sprinkler irrigation method is technically feasible in the study area. Provision of subsidy would encourage the farmers to adopt sprinkler irrigation system for a larger extent of crop cultivation. Further the training on the sprinkler irrigation system usage and the credit facilities to purchase appropriate water pumps could also contribute for the adoption of this technology.

## References

1. Al-Ghobari M. Effect of maintenance on the performance of sprinkler irrigation systems and irrigation water conservation. Food Sci. and Agric. Res. Center, King Saud Univ. Res. Bult. 2006;141:5-19.
2. Christiansen JE. Irrigation by Sprinkling. California Agriculture Experiment Station Bulletin, 1942, 670.
3. Isiguzo E Ahaneku. Performance evaluation of portable sprinkler irrigation system in Ilorin, Nigeria. Indian Journal of Science and Technology. 2010;3(07):853-857.
4. Li J, Rao M. Crop yield as affected by uniformity of sprinkler irrigation system. Agricultural Engg. Int: the CIGR J. Sci. Res. Dev. Manuscript 2004;LW01(004):111-116.
5. Luxmini KPAMK, Nanthakumaran A, Karunainathan. Technical feasibility Feasibility and The Performance of Sprinkler Irrigation System. International Research Journal of Environment Sciences. 2015;4(9):59-62.
6. Nasab SB, Baradarane-Hezave F, Behzad M. Technical evaluation of sprinkler irrigation systems in Arak. Iran. J. Appl. Sci. 2007;7(21):3338-3341.
7. Nasir Ul Rasheed Rather, Muddasir Ahmad Baba. Performance Evaluation of Sprinkler Irrigation System in Ganderbal District J&K State. Current Journal of Applied Science and Technology. 2017;25(5):1-7.
8. Patil P, Kulkarni U, Desai BL, Benagi VI, Naragund VB. Fuzzy logic based irrigation control system using wireless sensor network for precision agriculture. Proceedings AIPA 2012, India, 2012.
9. Sadler E, Evans R, Buchleiter G, King B, Camp C. Design considerations for site specific irrigation. In: Proceedings of the Fourth Decennial National Irrigation Symposium. RG Evans, BL Benham, and TP Trooien, eds. American Society of Agricultural Engineers. St. Joseph, Ml, 2000.