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# Life Saving Irrigation under Drought Condition for *Kharif* Crops in Vindhyan Zone (Mirzapur District), U.P

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## ABSTRACT

**Drought is an extended period when a region notes a deficiency in its water supply whether surface or underground water. Rainfall behaviour in drought prone areas is erratic and uncertain. The adverse effect of rainfall aberration on crop growth stage at such deviation occur suitable manipulation in crop management practices are needed to minimize such adverse effects of abnormal rainfall behaviour. It is essentially make provision for supplemental irrigation during critical dry spell periods by creating additional ground water storage wherever necessary and store the rainfall water when the heavy rainfall takes place and minimize the wastage of water. The mean date of onset of effective monsoon (OEM) in Mirzapur district varies from 30 June to 9 July and there is moderate variation in the dates of onset of effective monsoon in the different years. The date of withdrawal of monsoon from 18th August to 8th September. The maximum irrigation requirement is observed during CDS for rice as 106.79mm at Jargo and sugarcane as 88.66mm during dry spell.**

***Key words*** *Drought, life saving irrigation, onset monsoon etc*

Drought is generally defined as water shortage caused by the imbalance between water supply and demand. According to Indian Meteorological Department (IMD), a meteorological subdivision of India is considered to be affected by drought if it receives seasonal rainfall less than 75% of the normal value. According to the National Commission on Agriculture, 1976, agricultural drought refers to the inadequate soil moisture during crop growing period and the hydrological drought refers to marked depletion of surface water storage in lakes, reservoirs, rivers and streams etc. In fact, the meteorological drought precedes the agricultural and hydrological drought. Rahore, 2005 reported the conventional attitude to a drought as a phenomenon of arid and semi-arid areas is changing because even areas with high average rainfall often face acute water scarcity. Galkate, *et al.,* 2012 has carried out water availability study in Kharun river basin of Chhattisgarh state to estimate dependable flow in the river basin at various probability levels at different time periods and to analyze the flow regime under virgin and regulated condition using MIKE BASIN software and Flow Duration Curve technique. Guhathakurta, *et al*., 2006 have shown that there is no long term trend in the southwest monsoon seasonal rainfall over the country as a whole, but there are significant regional variations. Pandey, *et al.,* 2010 carried out drought study in Sonar basin of Ken River system in the Madhya Pradesh. The study was aimed at devising a suitable method for assessment of vulnerability to drought. The agricultural and hydrological drought need not to occur simultaneously but occur subsequent to a meteorological drought (Sastry, 1986). Thus, there is a need to develop suitable criteria for planning life saving irrigation to crops for increasing and stabilizing crop yields during drought conditions. The study is aimed at planning of life saving/ supplemental irrigation for rainfed crops to reduce water stress.

## MATERIALS AND METHODS

Mirzapur of district in Uttar Pradesh lies between the latitudes of 25°18 and 25° 32' N and longitudes 82°7' and 88°18' E. The average annual rainfall of Mirzapur district is 1063 mm. The temperature varies from 43°C in June, the hottest month, to -2°C in December the coldest.

### Onset of Effective Monsoon (OEM)

The date of onset of effective monsoon (OEM) can be defined as the date of commencement of a wet spell satisfying the following criteria (Verma and Sarma, 1989).

i) The first day's rain in 7- days spell is not less than average daily evapotranspiration (ET).

ii) At least four out of seven days are rainy days with not less than 2.5 mm of rain each day.

iii) The total rain during the 7- day spell is not less than (5ET + 10) mm.

**Table 1. Crop water requirement (ETc) for different time interval during growing period of rice crop**

| S.No. | Standard week | ETp (mm/day) | Kc | ETc (mm) |
|---|---|---|---|---|
| 1 | 25 | 6.1 | 1.1 | 46.72 |
| 2 | 26 | 5.1 | 1.1 | 39.63 |
| 3 | 27 | 4.6 | 1.1 | 35.25 |
| 4 | 28 | 4.2 | 1.1 | 32.30 |
| 5 | 29 | 4.0 | 1.1 | 31.01 |
| 6 | 30 | 3.9 | 1.05 | 28.47 |
| 7 | 31 | 4.1 | 1.05 | 30.06 |
| 8 | 32 | 4.2 | 1.05 | 30.67 |
| 9 | 33 | 3.3 | 1.05 | 24.00 |
| 10 | 34 | 3.5 | 1.05 | 26.05 |
| 11 | 35 | 3.8 | 0.95 | 25.48 |
| 12 | 36 | 3.7 | 0.95 | 24.34 |
| 13 | 37 | 3.6 | 0.95 | 24.11 |
| 14 | 38 | 3.3 | 0.95 | 22.15 |

Total Water Requirement of Rice = 420.25mm

Using the above definition rainfall record has been analyzed to identify the date of OEM in respective years.

## Mean date of OEM

The mean date of onset of effective monsoon is calculated as follows:

$$D_m = \sum_{i=1}^{n} \frac{X_i}{n} \quad \text{..... (i)}$$

Where, $D_m$ = mean date of effective monsoon, $X_i$ = date of onset of effective monsoon in $i^{th}$ year (i=1, 2...n) , n = total number of years for which rainfall date is being analyzed

For calculating the duration of critical dry spell, an appropriate approach is to divide the crop growth period into some important growth phases according to water demand as evapotranspiration of crop varies according to growth stages. In order to predict probable period of CDS, the median dates of beginning of 1st, 2nd and 3rd CDS, in growing season have been computed. The CDS has been decided on the basis of a crop and soil combination, the minimum length of a dry spell is considered as 10 days that become critical to the crops like rice, soyabean, sorghum, maize, pearl millet, black gram, vegetable, seasamum and sugarcane.

The potential crop evapotranspiration (ETp) has been estimated using modified penman method FAO (1963). The ETp (mm/day) for 52 standard weeks, has been calculated based on mean air temperature (maximum and minimum), dry bulb and wet bulb temperature),wind velocity, relative humidity (maximum and minimum), sun shine hours and using the standard table values given by Doorenbos and Pruitt (1977). The ETp estimates are made using meteorological data recorded at Banaras Hindu University, of Varanasi.

In order to, account for the effect of crop characteristics on ETp,the crop evapotranspiration (ETcrop) is calculated as follows.

ETcrop = Kc × ETp …… (ii)

Where, ETcrop = Crop-evapotranspiration, mm/day

ETp = Potential crop evapotranspiration, mm/day

Kc = crop coefficient

**Table 2. Average dates of onset and withdrawal of effective monsoon based on mean in different stations Mirzapur district**

| S.No. | Name of Station | Mean date of onset of monsoon | Standard deviation of onset (days) | Mean date of withdrawal of monsoon |
|---|---|---|---|---|
| 1 | Barkachha | 9 -July | 19 | 21 –Aug |
| 2 | Sadar | 30-June | 11 | 19-Aug |
| 3 | Chunar | 8-July | 16 | 8-Sept |
| 4 | Jargo | 4-July | 10 | 18-Aug |

**Table 3. Irrigation requirement (mm) for selected major crops during CDS in different sites in Mirzapur district**

| Name of Crop | Barkachha | Sadar | Chunar | Jargo |
|---|---|---|---|---|
| Rice | 40.42 | 55.46 | 7.01 | 106.79 |
| Soyabean | 15.49 | 48.29 | ** | 41.33 |
| Sorghum | 18.45 | 50.14 | ** | 56.47 |
| Maize | 29.68 | 60.49 | 8.65 | 86.71 |
| Pearl Millet | 15.49 | 40.12 | ** | 40.00 |
| Black Gram | 13.74 | 38.31 | ** | 42.29 |
| Vegetable | ** | 1.00 | ** | 20.57 |
| Seasamum | 7.8 | 29.61 | ** | 51.72 |
| Sugarcane | 31.00 | 47.20 | 12.49 | 88.66 |

** No irrigation required as crop period is over

## Irrigation requirement

In kharif season, crop failure happens due to water stress during critical dry spells. The irrigation water requirement for first three critical dry spells has been estimated as given in Table 2. The irrigation requirement (IR) of crop has been obtained as the difference between crop water requirement (ETcrop) and the effective rainfall (ER).

$$IR = ETcrop - ER \quad \text{.....(iii)}$$

## RESULTS AND DISCUSSION

## Assessment of drought

The mean annual rainfall in Mirzapur district varies from 955 mm at Sadar to 1142 mm at Barkachha, which indicate that there is spatial variation in the rainfall distribution pattern over the district. The Percentage probability of occurrence of 75% of mean annual rainfall has been worked out to delineate the drought proneness of various sites of the district Mirzapur. An area can be considered as drought prone if the probability of occurrence of 75% of normal rainfall is less than 80% (CWC, 1982). Percentage probability of occurrence of rainfall equivalent to the 75% of normal. All the sites in the district can be considered to be drought prone as the probability of occurrence of rainfall equivalent to 75% of normal annual rainfall is less than 80%. All the sites of district come under drought prone area shown in Fig.1-4.

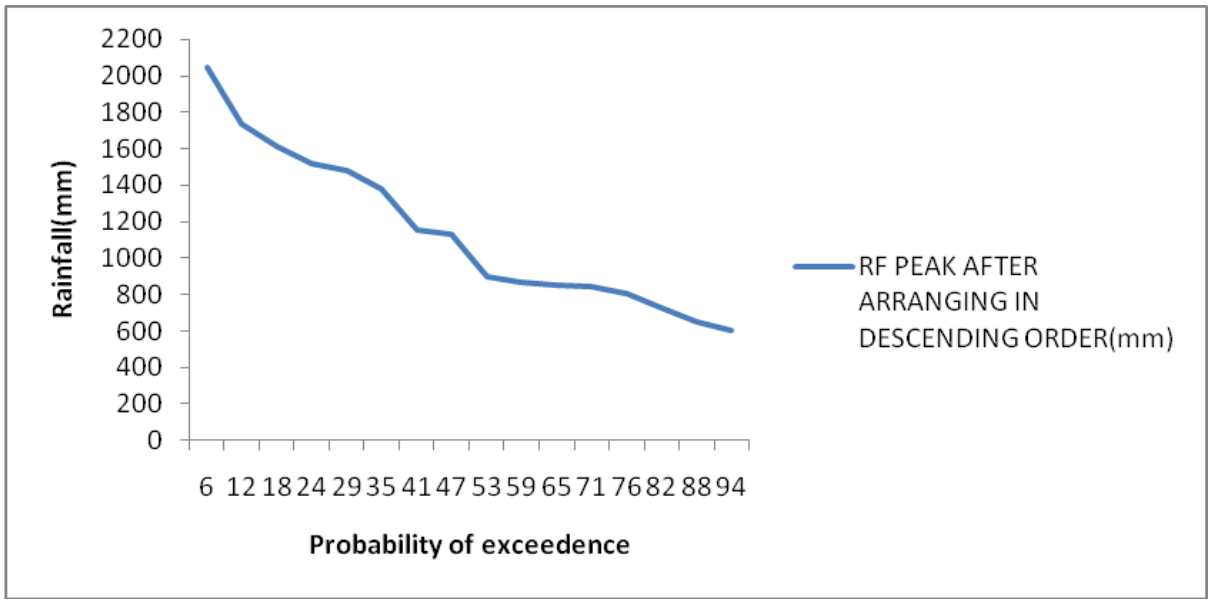


Fig 1. Probability of rainfall distribution curve of Barkachha station.

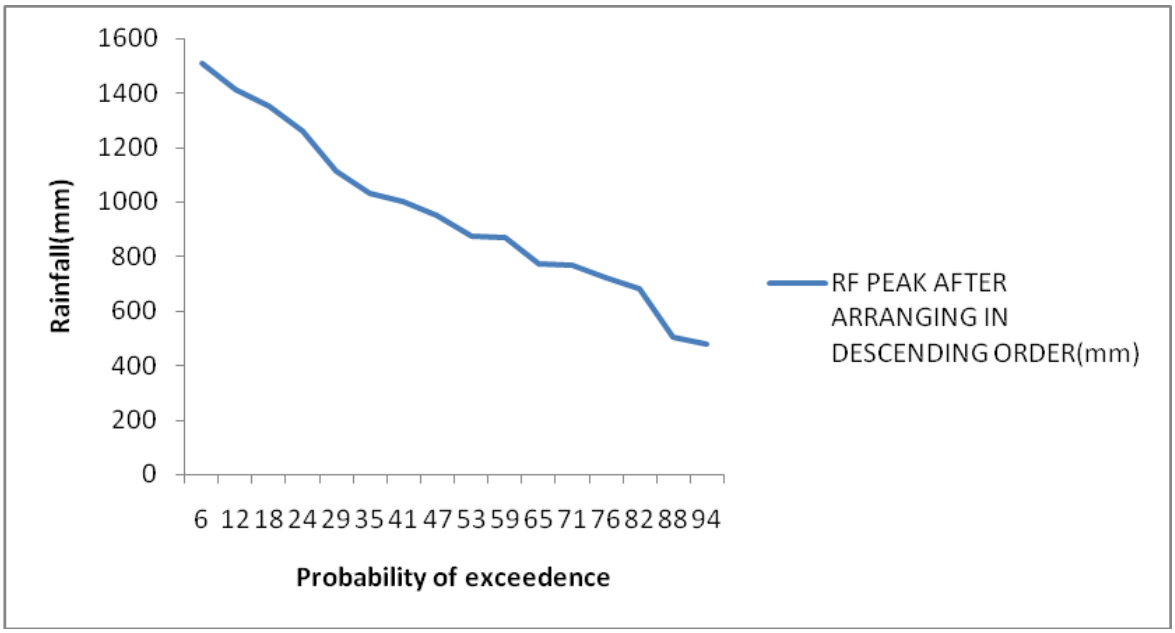


Fig 2. Probability of rainfall distribution curve of Sadar station

## Effective monsoon and CDS

The analysis of critical dry spell (CDS) indicated that there are three CDS per year on an average during the monsoon season. The first CDS is observed generally in last week of July and first week of august, second CDS observed in august second and third week where as third CDS has been observed in third week of September. It is essential to make provisions for life saving irrigation during these critical dry spell periods by creating additional storage wherever necessary. The mean date of onset of effective monsoon (OEM) in Mirzapur district represented is presented in Table 2.

## Irrigation requirement

The estimation of crop water requirement for different time interval during growing season of paddy crop is presented in Table 1. Similarly, the crop water requirement for other kharif crops has been computed. The irrigation requirement of kharif crops have been estimated for critical dry spell durations and the results

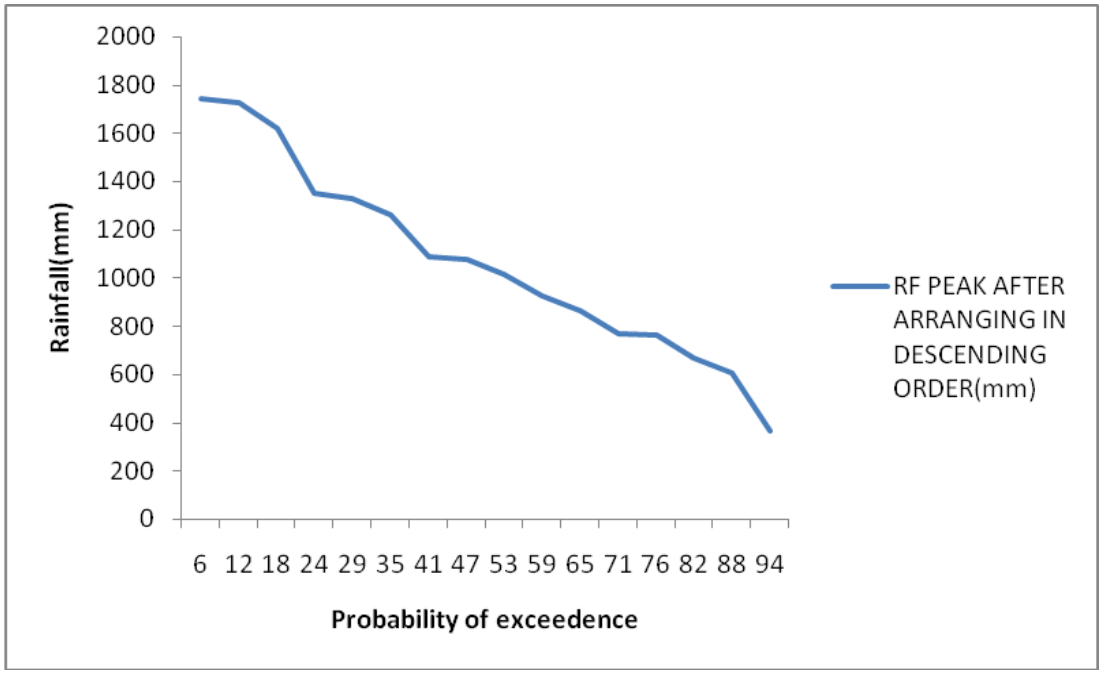


Fig 3. Probability of rainfall distribution curve of Chunar station

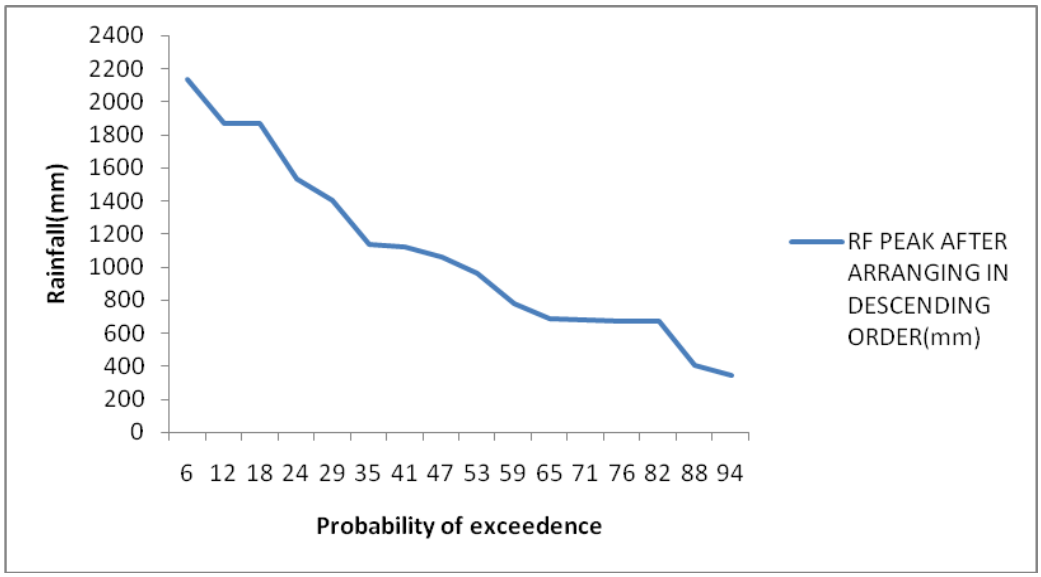


Fig 4. Probability of rainfall distribution curve of Jargo station

are presented in Table 2. It is observed that the total irrigation requirement for rice during the three critical dry spells varied from 7.01 mm at Chunar to 106.79 mm at Jargo. It can also be seen that the sugarcane crop has maximum irrigation requirement of 88.66 mm during three CDS at Jargo and minimum in Chunar areas. Maize, sugarcane, sorghum, soyabean and black gram are other important crops in the district, which require supplemental irrigation during dry spells. It is also seen that there is no need of supplemental irrigation in Chunar sites for crops like soyabean, sorghum, black gram, pearl millet, sesamum, vegetable etc.

The mean annual rainfall of Mirzapur district is 1063 mm estimated using four rainfall stations data with the deficiency of annual rainfall varying upto 16% in various stations of Mirzapur district. The probability of occurrence of rainfall show that the area is drought prone, which needs to be taken care of while planning for irrigation and other water resource project development in the district. As the probability of occurrence of rainfall equivalent to 75% of normal rainfall is less than 80% in most of the stations Mirzapur district can be considered as drought prone. It is essential to make provision for life saving irrigation for kharif crops by creating additional ground water storage wherever necessary and store the rainfall water when the heavy rainfall takes place and minimize the wastage of water. We can also make some water harvesting structures to store the water.

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