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# Identification of Onset Effective Monsoon, Dry Spell and Critical Dry Spell for Dimapur, Nagaland, India

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## ABSTRACT

Analysis of rainfall-related characteristics is an important problem in agrarian development and food production planning. Using daily rainfall and evaporation data for the Dimapur, Nagaland, an attempt to determine the onset of effective monsoon (OEM), dry spell (DS), and critical dry spell (CDS). The identification will aid groups in making crop planning decisions, whether they are directly or indirectly involved in agricultural output. Results revealed that in the year 2005 first OEM was detected in 2nd July of 27th week with a weekly rainfall of 16.60 mm. Similarly in the successive years i.e., 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019 and 2020 the first OEM were seen on 28th May of 22nd week, 5th February of 6th week, 4th June of 23rd week, 4th June of 23rd week, 16th April of 16th week, 11th June of 24th week, 30th July of 31th week, 7th May of 19th week, 30th July of 31st week,11th June of 24th week, 16th April of 16th week, 2nd June of 14th week , 11th June of 24th, 2nd July of 27th week and 21st May of 21st week. From the average value of all the years, the first OEM was observed in 21st week with 25.89 mm and the DS was observed in 30th, 36th and 38th week with 32.03 mm, 22.44 mm and 27.22 mm respectively. The CDS occurred successively in the first 20 weeks and last 11 weeks.

**Keywords** Critical dry spell, Dry spell, Onset of effective monsoon, Rainfall, Nagaland.

## INTRODUCTION

Rainfall plays a prominent role in rainfed agriculture. The rainfall distribution in India varies from region to region and rainfall varies from year to year. The main source of rainfall is South-West monsoon and at most of the places it is concentrated during four monsoon months. The rainfall during the monsoon season is always uncertain and its distribution within growing season is uneven (Kamble *et al.* 2014). According to Prasanna and Venkatraman

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(2014) the production of *Kharif* crops in India directly depends on the summer monsoon rainfall, whereas that of *Rabi* crops depends on the soil moisture availability, which in turn depends totally on the summer monsoon rainfall.

In India rainfed agriculture consists of 67% of net sown area, which contributes 44% of food grain and supports 40% of the population (CRIDA-ORP 1997). More than 70% of the people in Nagaland are involved in agriculture. Agriculture is one of the important aspects in the economy of the State and many villagers in the rural areas depend on it for their livelihood. Even though rainfall is plentiful in the region most of area faces water scarcity problems during the non-rainy seasons. Due to the hilly terrain runoff is high and there is loss of rainwater. Therefore, very less quantity of rainwater remains for utilization during the non-rainy season (Shekhar *et al*. 2018).

Therefore, it is necessary to evaluate the characteristics of rainfall that influences the crop production for successful crop planning and management. The information on occurrences of dry spells and quantity of rainfall during wet spells is very important for successful management of agriculture. The occurrence of dry spells during the growing season is one of the main reasons for crop failures. It is also vital to know the chances of occurrences of dry spells during the critical stages of the crops for determining cropping pattern, date of sowing, and planning of irrigation and other agricultural operations (Chaware and Satpute 2018). These information plays a vital role for management and planning of crop and cropping pattern. In most of the studies the researchers (Kamble *et al*. 2014 and Saren *et al.* 2023) have analyzed rainfall data to determine the dates of OEM and DS in different years using the criterion suggested by Ashok Raj (1979). In this study similar efforts have been made to study the weekly rainfall pattern for different years and for normal years for Dimapur and to identify OEM, DS and CDS for different years and normal years for Dimapur.

## MATERIALS AND METHODS

### *Location of study area*

A study was conducted for Dimapur, Nagaland which lies between 25°48′ and 26°00′ North latitude and 93°30′ and 93°54′ East longitude. The total geographical area of Dimapur district is 927 square kilometers. Daily rainfall data for fifteen years (2005–2020) and daily average evaporation data from 2006–2020 were collected from Daily rainfall data of Nagaland volume 1 published by Directorate of Soil and Water Conservation Kohima, Nagaland and Indian Council of Agricultural Research for NEH-region (ICAR), Jharnapani, Nagaland Center (Fig. 1).

### Determination of onset of effective monsoon (OEM), Critical dry spell (CDS) and Dry spell (DS)

### *Onset of effective monsoon*

The onset effective monsoon is defined on the basis of rainfall and evapotranspiration demand, which is relevant in the case of crops (Rao *et al.* 2008). The analysis in the present study was made on the basis of concept set by Ashok Raj (1979). According to this concept the date on commencement of seven days spell satisfying the following three criteria is taken as the date of OEM.

The first day's rain in the seven days spell should be more than the average daily evaporation (e) mm of the place.

The total rain during the seven days spell should be at least (5e+10) mm.

At least four out of these seven days should be having rainfall more than or equal to 2.5 mm.

By applying the above criterion, the mean date of onset effective monsoon 'm' was computed by using the equation as,

$$m = \frac{1}{N} \sum_{i=1}^{n} x_i$$

Where,

xi (i=1,2,3,n) = dates of onset of effective monsoon, n = Total number of years.

The standard deviation of $x_i$ (I = 1,2,3, n) dates of

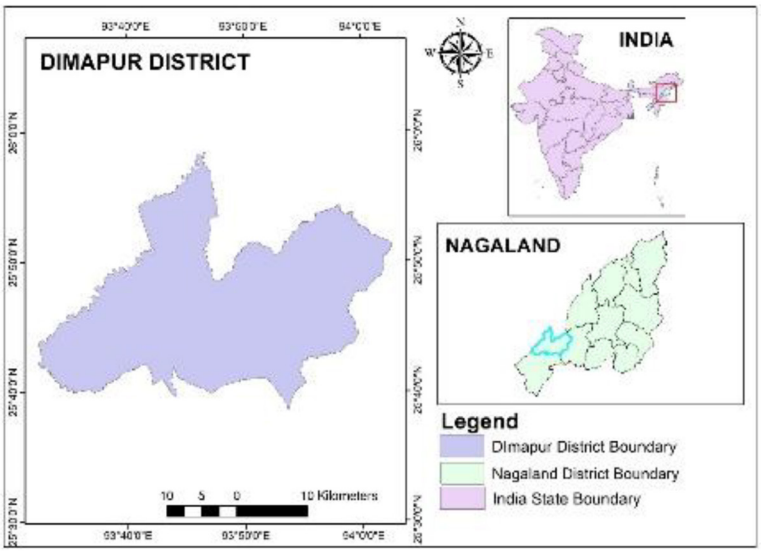


**Fig. 1.** Location map of study area.

OEM as calculated by using the following equation,

$$\sigma = \sqrt{\left\{ \frac{1}{(N-1)} \sum_{j=1}^{n} (x_i - m)^2 \right\}}$$

The significance of the criteria is obvious by the fact that the first day's rain of seven days after prolonged dry spell will not contribute any water to soil if it is less than the average evaporation of that day.

**Dry spell (DS)**

Subsequent spells that do not meet OEM standards after the monsoon season begins are regarded as dry spells. The criteria outlined by Ashok Raj (1979) were used to determine the dry spells. The first dry spell is defined as the time between the OEM, which is regarded as the first wet spell, and the start of the subsequent wet phase. A seven-day period with rainfall at least equal to 5e (e is the average daily evaporation) and four rainy days with rainfall of at least 2.5 mm is a good way to define the subsequent wet spell after OEM, which is the time between two consecutive dry spells.

According to the region's crop soil complex, short-term dry spells merge into seven-day wet spells and long-term dry spells occur. Critical dry spells are defined as prolonged periods without rain or with likely significant interspersing dry periods that impact crop growth. Every year's dry spells were identified using the specified criterion for effective planning, and they were categorized by monsoon season (June-September) metrological week or month. Every particular week was given a dry spell duration that either began or ended during that week, with the longest dry spell duration. If there are two dry spells occurring in the same week and lying in the week, then the greater duration dry spell out of two was taken for analysis.

**Critical dry spell (CDS)**

If the duration of dry spell surpasses certain value depending upon crop soil climate complex of the region this dry spell was called the critical dry spell (CDS). Duration of 10 days was taken into account to classify the dry spell as critical in this study. The mean dates of starting of critical dry spells were found by the same procedure implemented for procurement of the mean dates of OEM.

## RESULTS AND DISCUSSION

Records of daily rainfall data for fifteen years (2005−2020) for Dimapur district was obtained

from Directorate of Soil and Water Conservation Kohima, Nagaland and evaporation data for the year 2006-2020 was collected from Indian Council of Agricultural and Research Center (ICAR) Jharnapani, Dimapur. Data were determined to analyze weekly rainfall for the purpose of contingent crop advisory. Daily rainfall for fifteen years (2005−2020) and the mean evaporation data were used for determining OEM, CDS and DS.

**Weekly rainfall**

Table 1 and Fig. 2 show the normal weekly rainfall of Dimapur. Results reveal that, the highest rainfall week was found in 26$^{th}$ week with 6.85 mm rainfall and lowest rainfall was in 52$^{nd}$ week with rainfall of 0.02 mm. It was clearly seen that, the first 14 weeks and last 9 weeks has comparatively low rainfall than the other remaining weeks. It was also found that, higher rainfalls were seen during 15$^{th}$ to 43$^{rd}$ weeks.

**Determination of OEM, DS and CDS**

Efforts were also made to identify OEM, DS and CDS

**Table 1.** Normal weekly rainfall.

| Weeks | Rainfall in mm | Weeks | Rainfall in mm |
|---|---|---|---|
| 1 | 0.10 | 27 | 5.08 |
| 2 | 0.20 | 28 | 4.17 |
| 3 | 0.18 | 29 | 5.96 |
| 4 | 0.12 | 30 | 4.58 |
| 5 | 0.31 | 31 | 6.21 |
| 6 | 0.47 | 32 | 3.60 |
| 7 | 0.47 | 33 | 4.61 |
| 8 | 0.12 | 34 | 4.37 |
| 9 | 0.32 | 35 | 6.50 |
| 10 | 0.23 | 36 | 3.21 |
| 11 | 0.38 | 37 | 4.18 |
| 12 | 1.25 | 38 | 3.89 |
| 13 | 1.13 | 39 | 3.77 |
| 14 | 1.55 | 40 | 3.73 |
| 15 | 2.06 | 41 | 5.66 |
| 16 | 2.83 | 42 | 1.72 |
| 17 | 2.64 | 43 | 3.38 |
| 18 | 2.27 | 44 | 0.27 |
| 19 | 3.70 | 45 | 0.94 |
| 20 | 2.46 | 46 | 0.60 |
| 21 | 3.98 | 47 | 0.21 |
| 22 | 4.74 | 48 | 0.04 |
| 23 | 4.95 | 49 | 0.09 |
| 24 | 6.15 | 50 | 0.09 |
| 25 | 5.94 | 51 | 0.20 |
| 26 | 6.85 | 52 | 0.02 |

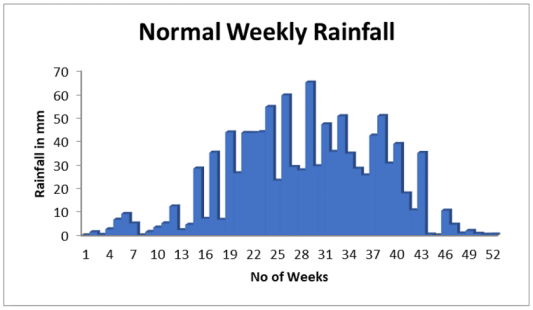


**Fig. 2**. Normal weekly rainfall of Dimapur.

weeks of the year as discussed below.

**Onset of effective monsoon (OEM)**

Based on the method of finding OEM with reference to Ashok Raj (1979), while assessing for normal data, the first OEM was found at 21$^{st}$ week of the years (Table 2). It was observed that, the rainfall of the first day of the 19$^{th}$ week i.e., 6.74 mm was more than the average daily evaporation rate i.e., 2.74 mm, which satisfy the first condition of OEM criteria. It was also revealed that, there are 18 numbers of week out of total 52 weeks, is identified as OEM weeks.

From the result, it can also be seen that, OEM usually occurs during the month of May, June, July with a maximum rainfall of 47.95 mm in the 26$^{th}$ week and minimum of 25.19 mm in the 32$^{nd}$ week. It was also found that, the last OEM period was observed in the 41$^{st}$ week with the rainfall of 39.64 mm. It may be mention that most of the OEM weeks are found during monsoon season.

**Dry spell (DS)**

While identifying DS weeks with the criteria set by Ashok Raj (1979) DS weeks were seen in 30$^{th}$ 36$^{th}$ and 38$^{th}$ week of the year, with weekly rainfall of 32.03 mm, 22.44 mm and 27.22 mm. It is clear that DS weeks are rare phenomenon and occurs at a sudden period of time.

**Critical dry spell (CDS)**

It can be seen that CDS usually occurs during the

**Table 2.** Weekly rainfall distribution (mm) and classification into CDS, OEM and DS over the study period.

| Weeks | Rainfall (mm) | OEM/CDS/DS | Weeks | Rainfall (mm) | OEM/CDS/DS |
|---|---|---|---|---|---|
| 1 | 0.69 | CDS | 27 | 35.59 | OEM |
| 2 | 1.43 | CDS | 28 | 29.17 | OEM |
| 3 | 1.25 | CDS | 29 | 41.75 | OEM |
| 4 | 0.86 | CDS | 30 | 32.03 | DS |
| 5 | 2.14 | CDS | 31 | 43.50 | OEM |
| 6 | 3.27 | CDS | 32 | 25.19 | OEM |
| 7 | 3.30 | CDS | 33 | 32.28 | OEM |
| 8 | 0.81 | CDS | 34 | 30.61 | OEM |
| 9 | 2.22 | CDS | 35 | 45.53 | OEM |
| 10 | 1.63 | CDS | 36 | 22.44 | DS |
| 11 | 2.68 | CDS | 37 | 29.29 | OEM |
| 12 | 8.76 | CDS | 38 | 27.22 | DS |
| 13 | 7.90 | CDS | 39 | 26.39 | OEM |
| 14 | 10.85 | CDS | 40 | 26.11 | OEM |
| 15 | 14.39 | CDS | 41 | 39.64 | OEM |
| 16 | 19.79 | CDS | 42 | 12.01 | CDS |
| 17 | 18.47 | CDS | 43 | 23.69 | CDS |
| 18 | 15.86 | CDS | 44 | 1.88 | CDS |
| 19 | 25.89 | CDS | 45 | 6.61 | CDS |
| 20 | 17.19 | CDS | 46 | 4.21 | CDS |
| 21 | 27.85 | OEM | 47 | 1.49 | CDS |
| 22 | 33.17 | OEM | 48 | 0.31 | CDS |
| 23 | 34.63 | OEM | 49 | 0.64 | CDS |
| 24 | 43.06 | OEM | 50 | 0.60 | CDS |
| 25 | 41.59 | OEM | 51 | 1.40 | CDS |
| 26 | 47.95 | OEM | 52 | 0.16 | CDS |

beginning and at the end of the year with some of its effects in between the year. Rainfall during CDS can rise to a maximum of 25.89 mm and to a minimum of 0.16 mm. On the monthly basis CDS rainfall is at its maximum in the month of June and July and minimum in the month of December and January. The CDS occurred successively in the first 20 weeks with rainfall as high as 25.89 mm in the 19$^{th}$ week. And also, during the last 11 weeks with the highest rainfall of 23.69 mm in the 43$^{rd}$ week.

**Determination of OEM on yearly basis**

For the year 2005 the first OEM was identified on 2$^{nd}$ July of 27$^{th}$ week and weekly rainfall of 16.60 mm (Table 3). Similarly, the 2$^{nd}$ OEM was identified on 32$^{nd}$ week with weekly rainfall of 11.86 mm.

For the year 2006 the first OEM occurred on 28$^{th}$ May of 22$^{nd}$ week with weekly rainfall of 14.35 mm. The 2$^{nd}$ OEM was identified on the 33$^{rd}$ week with weekly rainfall of 8.89 mm. The last OEM was identified on the 35$^{th}$ week with weekly rainfall of 3.58 mm. Dry spell occurred only during this particular year and the first DS was identified on 20$^{th}$ August of 34$^{th}$ week with weekly rainfall of 3.63 mm (Table 4).

In the year 2007 the first OEM occurred on 5$^{th}$ February of 6$^{th}$ week with weekly rainfall of 6.6 mm. The second OEM occurred in the 17$^{th}$ week with weekly rainfall of 9.03 mm.

The third OEM occurred in the 23$^{rd}$ week with weekly rainfall of 3.54 mm. The fourth OEM occurred in the 26$^{th}$ week with weekly rainfall of 14.33 mm. The last OEM occurred in the 36$^{th}$ week with weekly rainfall of 15.63 mm. Although the first OEM occurred on the 5$^{th}$ February of 6$^{th}$ week, the first OEM of the monsoon season i.e., of 4$^{th}$ June of 23$^{rd}$ week was considered.

For the year 2008 the first OEM was identified on 4$^{th}$ June of 23$^{rd}$ week with weekly rainfall of

**Table 3.** Year-wise occurrence of OEM and DS with corresponding weeks and daily rainfall (mm) during the study period.

| Years | Month of Fall of OEM and DS | First OEM | First DS | Daily rainfall of the OEM week (mm) | Daily rainfall of the DS week |
|---|---|---|---|---|---|
| 2005 | 2nd July | 27th Week | | 6.20, 14.20, 42.60, 14.60, 0.00, 3.00, 35.60 | |
| 2006 | 28th May | 22th Week | | 69.60, 18.60, 5.20, 7.00, 0.00, 0.00, 0.00 | |
| | 20th Aug | | 34th Week | | 4.20, 21.20, 0.00, 0.00, 0.00, 0.00, 0.00 |
| 2007 | 4th Jun | 23th Week | | 3.20, 0.00, 3.20, 12.20, 4.40, 1.80, 0.00 | |
| 2008 | 4th Jun | 23th Week | | 15.20, 23.20, 5.80, 5.20, 21.20, 25.20, 6.20 | |
| 2009 | 4th Jun | 23th Week | | 32.00, 0.00, 0.50, 17.20, 16.00, 0.20, 67.10 | |
| 2010 | 16th April | 16th week | | 5.4, 34.2, 16.2, 8.6, 8.8, 0.00, 0.00 | |
| 2011 | 11th Jun | 24th week | | 5.4, 0.00, 4.00, 2.8, 3.2, 2.3,88.9 | |
| 2012 | 30th Jun | 31st week | | 24, 0.00,0.2, 42, 0.00, 0.0, 4.00 | |
| 2013 | 7th May | 19th week | | 8.5, 0.00, 78.6, 11.8, 0.00, 4.8, 7.2 | |
| 2014 | 30th July | 31st week | | 18.2, 0.00, 12.00, 5.4, 16.00, 0.00, 0.00 | |
| 2015 | 11th Jun | 24th week | | 6.2, 3.6, 15.2, 0.00, 0.00, 3.8, 0.00 | |
| 2016 | 16thApril | 16th week | | 10.8, 0.00, 4.2, 16.8, 4.3, 25.3, 0.00 | |
| | | | 25th week | | 14.2, 34.2, 0.00, 0.00, 0.00, 0.00, 0.00 |
| 2017 | 2nd Jun | 14th week | | 11.2, 9.6, 10.2, 19.2, 3.8, 1.8,0.00 | |
| | | | 25th week | | 0.00, 0.00, 0.00, 3.00, 0.00, 3.00, 24.2 |
| | | | 27th week | | 0.2, 0.00, 0.00, 4.00, 22.4, 0.00, 0.00 |
| 2018 | 11th Jun | 24th week | | 0.2, 4.00, 44.8, 15.6, 0.00, 0.00, 0.00 | |
| 2019 | 2nd July | 27th week | | 0.00, 8.2, 0.00, 0.00, 48.8, 4.2, 3.00 | |
| 2020 | 21stMay | 21st week | | 4.6, 0.3, 0.2, 4.2, 0.3, 4.00, 52.4 | |

14.57 mm. The last OEM was identified on the 31st week with a weekly rainfall of 9.07 mm.

For the year 2009 the OEM occurred on 4rth June of 23rd week with a weekly rainfall of 19.00 mm.

For the year 2010 the first OEM was identified on 16th April of 16th week and weekly rainfall of 10.45 mm. Similarly, the 2nd OEM was identified on 25th week with weekly rainfall of 11.6 mm.

For the year 2011 the first OEM occurred on 11th June of 24th week with weekly rainfall of 15.22 mm. The 2nd OEM was identified on the 25th week with weekly rainfall of 8.95 mm.

In the year 2012 the first OEM occurred on 30th July of 31th week with weekly rainfall of 10.02 mm. The second OEM occurred in the 40th week with weekly rainfall of 12 mm.

In the year 2013 the first OEM occurred on 7th May of 19th week with weekly rainfall of 15.84 mm. The second OEM occurred in the 20th week with weekly rainfall of 3.3 mm.

In the year 2014 the first OEM occurred on 30th July of 31th week with weekly rainfall of 7.37 mm. The second OEM occurred in the 38th week with weekly rainfall of 5.65 mm.

In the year 2015 the first OEM occurred on 11th June of 24th week with weekly rainfall of 4.14 mm. The second OEM occurred in the 25th week with weekly rainfall of 6.1 mm. The third OEM occurred in the 34th week with weekly rainfall of 2.82 mm. The fourth OEM occurred in the 37th week with weekly rainfall of 6.37 mm.

**Table 4.** Identified OEM weeks for different years with their corresponding daily rainfall of the week.

| Years | Identified OEM weeks | Daily rainfall of the OEM week (mm) |
|---|---|---|
| 2005 | 27th week | 6.20, 14.20, 42.60, 14.60, 0.00, 3.00, 35.60 |
| | 32nd week | 32.20, 0.00,9.40, 0.00, 22.60, 16.20, 2.60 |
| | 22nd week | 69.60, 18.60, 5.20, 7.00,0.00, 0.00,0.00 |
| 2006 | 33rd week | 4.20, 41.20,0.00,0.00,0.00,13.20,3.60 |
| | 35th week | 9.20,4.60,0.00,0.00,2.20,0.00,9.00 |
| | 6th week | 3.40,31.60,0.00,8.20,3.00,0.00,0.00 |
| | 17th week | 6.80,3.20,3.40,5.00,9.20,35.00,0.60 |
| 2007 | 23rd week | 3.20, 0.00, 3.20,12.20,4.40,1.80,0.00 |
| | 26th week | 17.70,14.60,0.00,0.00,57.80,0.00,10.20 |
| | 36th week | 4.40,0.20,25.20,26.20,12.00,17.20,24.30 |
| | 23rd week | 15.20,23.20,5.80,21.20,25.20,6.20 |
| 2008 | 31st week | 16.80,0.10,23.20,13.20,10.20,0.00,0.00 |
| 2009 | 23rd week | 32.00,0.00,0.50,17.20,16.00,0.20,67.10 |
| 2010 | 16th week | 5.4, 34.2, 16.2, 8.6, 8.8, 0.00, 0.00 |
| | 25th week | 48.2, 0.00, 0.00, 8.8, 0.00, 0.00, 24.2 |
| 2011 | 24th week | 5.4, 0.00, 4.00, 2.8, 3.2, 2.3, 88.9 |
| | 25th week | 0.00, 0.00, 9.5, 0.00, 53.2, 0.00, 0.00 |
| 2012 | 31th week | 24, 0.00,0.2, 42, 0.00, 0.00, 4.0 |
| | 40th week | 4.00, 0.00, 7.00, 61.00, 12.00, 0.00 |
| 2013 | 19th week | 8.5, 0.00, 78.6, 11.8, 0.00, 4.8, 7.2 |
| | 20th week | 0.00, 0.00, 2.8, 16.5, 3.8, 0.00, 0.00 |
| 2014 | 31th week | 18.2, 0.00, 12.00, 5.4, 16.00, 0.00, 0.00 |
| | 38th week | 0.00, 0.00, 2.6, 6.8, 3.2, 1.8, 25.2 |
| 2015 | 24th week | 6.2, 3.6, 15.2, 0.00, 0.00, 3.8, 0.00 |
| | 25th week | 2.00, 0.00, 3.6, 0.00, 2.3, 19.00, 15.8 |
| | 34th week | 3.00, 8.8, 0.00, 4.8, 0.00, 0.00, 3.2 |
| | 16th week | 10.8, 0.00, 4.2, 16.8, 4.3, 25.3, 0.00 |
| | 20th week | 2.2, 0.00, 9.2, 3.00, 18.00, 10.2, 4.6 |
| | 24th week | 14.00, 0.00, 3.00, 0.00, 10.4, 0.00, 3.2 |
| 2016 | 26th week | 0.00, 3.2, 10.2, 4.2, 67.4, 0.00, 0.00 |
| | 27th week | 0.00, 11.2, 25.2, 19.2, 22.00, 6.00, 0.00 |
| | 36th week | 0.00, 0.00, 24.00, 16.2, 32.4, 2.00, 17.00 |
| | 37th week | 0.00, 2.8, 0.00, 0.00, 4.6, 4.2, 5.2 |
| | 38th week | 0.00, 4.2, 3.2, 0.00, 17.00, 40.2, 9.00 |
| | 24th week | 0.2, 4.00, 44.8, 15.6, 0.00, 0.00, 0.00 |
| 2018 | 30th week | 8.8, 0.00, 8.8, 5.00, 8.2, 0.00, 4.2 |
| | 31st week | 0.00, 6.2, 68.2, 39.8, 0.00, 0.00, 8.8 |
| 2019 | 34th week | 0.00, 15.00, 0.00, 0.00, 44.2, 5.2, 66.2 |
| | 27th week | 0.00, 8.2, 0.00, 0.00, 48.8, 4.2, 3.00 |
| 2020 | 21st week | 4.6, 0.3, 0.2, 4.2, 0.3, 4.00, 52.4 |
| | 30th week | 28.2, 40.4, 0.00, 0.3, 22.2, 20.4, 20.2 |

In the year 2016 the first OEM occurred on 16th April of 16th week with weekly rainfall of 8.77 mm. The second OEM occurred in the 20th week with weekly rainfall of 6.45 mm. The third OEM occurred in the 24th week with weekly rainfall of 4.51 mm. The fourth OEM occurred in the 26th week with weekly rainfall of 12.14 mm. The fifth OEM occurred in the 27th week with weekly rainfall of 11.94 mm. The sixth OEM occurred in the 36th week with weekly rainfall of 13.08 mm. The seventh OEM occurred in the 37th week with weekly rainfall of 2.4 mm. The eight OEM occurred in the 38th week with weekly rainfall of 10.51 mm.

In the year 2017 the first OEM occurred on 2nd June of 14th week with weekly rainfall of 7.97 mm. The second OEM occurred in the 21st week with weekly rainfall of 2.94 mm. The third OEM occurred in the 24th week with weekly rainfall of 3.3 mm. The fourth OEM occurred in the 26th week

with weekly rainfall of 7.9 mm. The fifth OEM occurred in the 28th week with weekly rainfall of 9.6 mm. The sixth OEM occurred in the 39th week with weekly rainfall of 9.45 mm.

In the year 2018 the first OEM occurred on 11th June of 24th week with weekly rainfall of 9.22 mm. The second OEM occurred in the 30th week with weekly rainfall of 5.00 mm. The third OEM occurred in the 31st week with weekly rainfall of 17.57 mm. The fourth OEM occurred in the 34th week with weekly rainfall of 18.65. In the year 2019 the first OEM occurred on 2nd July of 27th week with weekly rainfall of 9.17 mm.

In the year 2020 the first OEM occurred on 21st May of 21st week with weekly rainfall of 9.42 mm. The second OEM occurred in the 30th week with weekly rainfall of 18.81 mm.

The period of onset of effective monsoon begins on 21st week and ends at 41st week with some dry spell in between. Since the amount of rainfall is good in this period, it helps in growing cereal and other commercial crops in the region of Dimapur. Since winter season gets only 6.61 mm maximum rainfall, it is necessary to construct water harvesting system, to store excess water during rainy season. Studies highlight that uneven rainfall distribution and continued dry periods require the adoption of water conservation practices to sustain agricultural production (Muralikrishnan *et al*. 2021). Dimapur with an area of 121 $km^2$ with good fertile land is well suited for growing crops when there is a good amount of rainfall during monsoon-season.

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