

**CHARACTERIZATION OF RAINFALL FOR CROP PLANNING IN
JALGAON DISTRICT OF MAHARASHTRA**

by

Mr. Shinde Prashant Balasaheb

(Reg. No.016/326)

A Thesis submitted to the
**MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI-413 722, DIST-AHMEDNAGAR,
MAHARASHTRA STATE (INDIA)**

In partial fulfillment of the requirements for the degree
of
MASTER OF SCIENCE (AGRICULTURE)
in
AGRICULTURAL METEOROLOGY



**DEPARTMENT OF AGRICULTURAL METEOROLOGY
CENTRE FOR ADVANCED FACULTY TRAINING (CAFT) IN
AGRICULTURAL METEOROLOGY
COLLEGE OF AGRICULTURE, PUNE-411 005
MAHATMA PHULE KRISHI VIDYAPEETH
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MAHARASHTRA, INDIA**

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RAHURI-413 722 DIST-AHMEDNAGAR
MAHARASHTRA, INDIA**

2018

Dedication

Ecstatically dedicated my thesis to

Aai and Baba

ANYTHING GOOD THAT

HAS COME TO MY LIFE

HAS

BECAUSE OF

YOUR EXAMPLE, GUIDANCE AND LOVE

CANDIDATE'S DECLARATION

**I hereby declare that this thesis or part
thereof has not been submitted
by me or other person to any
other University or Institute
for a Degree or
Diploma**

Place: Pune

Date: / / 2018

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The assistance and the help received during the course of this investigation have been duly acknowledged.

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(Shinde P. B.)

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ABBREVIATIONS

%	Per cent
°C	Degree celcius
Aug.	August
Cont.	Contribution
CRIDA	Central Research Institute for Dryland Agriculture
C. V.	Coefficient of variation
def	Deficit
ET	Evapotranspiration
<i>et al.</i>	et all (and others)
ha	Hectare
<i>i.e.</i>	id est (that is)
Kg/ha	Kilogram per hectare
LGP	Length of Growing Period
m	Meter
Max	Maximum
Min	Minimum
mm	Millimeter
MW	Meteorological week
NE	North-East
No.	Number
Nos.	Numbers
Nov.	November
PET	Potential evapotranspiration
pH	Potential of hydrogen ion
RD	Rainy day
RF	Rainfall
S. D.	Standard deviation
Sept.	September
sur	Surplus
<i>Viz.,</i>	Videlicet (namely)
ZARS	Zonal Agricultural Research Station

ABSTRACT

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**MAHATMA PHULE KRISHI VIDYAPEETH, RAHURI - 413 722
2018**

Research Guide : Dr. J. D. JADHAV
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The daily tahasilwise rainfall data of Jalgaon district was collected and studied for intra seasonal, yearly, monthly as well as weekly variations and its deviation from normal of corresponding temporal variation.

The data revealed that amongst the various tahasils, the annual rainfall ranged between 623.1 mm to 748.2 mm. The average annual rainfall was 698.8 mm. The average annual rainfall for the district was received in 43 days.

The seasonal rainfall is much more important for suggesting the cropping pattern. South-west monsoon played most important role in all the tahasils of Jalgaon district which is assured rainfall for *kharif* crops of different growing periods such as short duration and medium duration crops can be safely grown under *rainfed* cropping system. However, the good quantum of rainfall received in North-east monsoon season (post-monsoon) can help in proper establishment and early growth of *rainfed rabi* crops particularly. The summer showers are important from preparatory tillage point of view.

There was significant variation in the monthly rainfall variability across the district and the tahasils particularly. The major portion of rainfall concentrated during the months of June, July, August and September. However, a good quantum of rainfall was also recorded in the month of October. During the early months of year *i.e.* January to May as well as month of November and December a very meager amount of rainfall was recorded in almost all the tahasils.

The variation in rainfall from agricultural management point of view is much more important when considered on weekly basis. The study revealed that the monsoon season is very much ideal for agricultural enterprise in the district. The commencement of rainy season in the district on an average was noticed in 23rd to 28th MW and persistence of monsoon activities in the following weeks strongly suggested to initiate sowing operation in 24 MW onwards.

Sometimes there is break in monsoon activity and vagaries of monsoon has experienced dry spell which adversely affect the crop growth. The analysis showed that the more chance of

occurrence of dry spell at 42 MW in all tahasils of Jalgaon district, so care has to be taken that fertilizer application, hoeing and weeding should be avoided.

The frequency distribution analysis for annual rainfall indicated that out of 56 years, the normal rainfall ranged between 42 years. The data showed that average number of drought years of district for no drought, moderate drought and severe drought were 42, 10 and 1 with contribution of 79.2, 19.4 and 1.6 per cent, respectively. Thus, the data revealed that the district is favourable for assured rainfall conditions useful for cultivation of various crops during the year.

Onset and withdrawal of monsoon by frequency analysis of weekly rainfall revealed that the mean onset of rainy season at 24 MW, early onset was at 23 MW and late onset ranged between 25 to 28 MW while mean termination of rainy season was ranged in 41 to 44 MW, early termination in 30 to 39 MW and late termination occurs at 50 to 52 MW. The start and end of rainy season by forward and backward accumulation, the start of rainy season at probability of about 60 per cent rainfall ranged between 23 to 25 MW while the end of rainy season ranged between 41 to 52 MW for all the tahasils. The suitable cropping pattern is suggested according to all these observations and the depth and type of soil. Based on the onset and withdrawal of rainfall, the LGP was worked out which ranged from 91 to 181 days for the district.

Based on the analysis of rainfall and soil type, cropping pattern was suggested for effective utilization of soil moisture for sustainable production. During the *kharif* season, crops *viz.*, sorghum, cotton, pearl millet, groundnut, soybean, maize, pulses like red gram, green gram while in *rabi*, wheat, sorghum, gram, maize, safflower, should be prominently cultivated. Horticultural crops *viz.*, cabbage, carrot, brinjal, okra, onion, tomato, banana, acid lime, sweet orange, tagates, aster, chilli, sweet potato and custard apple can be grown under assured rainfall conditions which improve farm income and are remunerative.

Statistical analysis

The data collected for each tahasil of Jalgaon district were subjected to statistical analysis such as standard deviation, coefficient of variation extreme lowest and the highest mean, starting, ending and duration of rainy season. All these parameters are calculated from the computerized programme named Weather Cock developed by PC Unit, AICRPAM, CRIDA, Hyderabad.

On the basis of analysis of 56 years of rainfall data, the cropping pattern was suggested according to soil type prevailing in Jalgaon district.

1. INTRODUCTION

India, a primarily agrarian country which situated in south Asian region which is second largest country in population in world after China. It is seventh largest country in geographical area in world which contribute about 2.4 per cent land of world. India is surrounded by Indian Ocean from south, east, west side and by Himalayan ranges from north side. These acts as natural boundaries to country due to which climate of Indian subcontinent differs from other region of world.

As the Indian agrarian country, small changes in climatic condition it largely affects the countries economy. India is dependent on rain for 60 per cent of its net sown agricultural area. The southwest monsoon (June-September) provides about 80 per cent of the area's precipitation. As can be expected, a good monsoon season with sufficient rainfall results in enhanced agricultural production, whereas, a bad monsoon season with low precipitation negatively impacts the economy through lower production.

In the recent years, the important scientific challenge faced by researchers worldwide is to have a better understanding about climate change at a regional scale. However, for all the regions the changes are unequal and have localized intensity. Therefore, it should be quantified at a local scale. Rainfall is one of the important climatic variables responsible for climate change and required to be studied thoroughly. Maharashtra state is situated in west coast of India and agriculture plays a vital role in the state's economy which is greatly dependent on rainfall. Any change in rainfall pattern due to climate change can adversely affect the agricultural production.

Rainfall variation will be one of the important factors for determination of overall impacts of climate change. Systematic and instant attention should be given towards the variation of rainfall since it affects the food production and availability of fresh water (Dore, 2005). Cruz *et al.*, (2007) reported that change in the rainfall pattern has considerable impact on water and agriculture sector of Asia Pacific region. The extreme events like floods, draughts are frequently occurring as a result of growth in population, increased urbanization and increased intensity of rainfall. Therefore, worldwide several studies have been conducted regarding the analysis of spatial and temporal variations in rainfall to observe the effect of climate change.

According to the report of Intergovernmental Panel on Climate change (IPCC, 2017) the seasonal, annual and spatial variation in precipitation trends were observed during past decades in all over Asia. It has been observed that precipitation has increased within 10° N to 30° N for few decades from the year 1900 onwards and a decrease has noticed after 1970. A decreasing rainfall trend was noticed in the tropical areas from 10° N to 10° S, whereas, the tropical and sub-tropical regions were facing increased draughts due to decrease in precipitation since 1970.

Generally, rainfall varies from east to west while temperature varies from south to north. Thus, highly variable climate prevails in the country, because of Himalayan range in north, Vindhyachal at middle, Sahyadri at west coast and Eastern ghat at east coast. The soil type and depth also varies from place to place. Despite of considerable overall technological advancement and improved irrigation facilities in the country, farmers continue to be dependent on seasonal rains which are highly erratic in behavior. Somewhere it pours and somewhere it never rains. Onset and withdrawal of monsoon is highly variable in nature. When one part of country suffers from heavy flood, some other part suffers from severe drought. This clearly indicates that country as a whole experiences variety of weather in a year. These extreme conditions have a great impact on crop production and productivity in particular.

Drought also affects all parts of our environment as well as our communities. Different types of droughts have varying economic, environmental and social impacts. Approximately 16 per cent of India's geographical area, mostly arid, semi-arid and sub-humid is drought-prone (GoI 2013a). Due to high temporal and spatial variability in rainfall and wide variations in physiographic and climatic conditions in the country, droughts are experienced in varying intensities (moderate or severe) almost every year irrespective of a good monsoon. Since 2001, the country has experienced three major droughts in the years of 2002, 2004 and 2009, severely affecting the various sectors and overall economic development of the country.

In Maharashtra, net sown area is about 173.86 Lakh ha which contribute 12.4 per cent and gross cropped area is 231.2 Lakh ha which contribute about 11.9 per cent to the India's gross cropped area. As far as irrigated area concerned, the state has 17.9 per cent of total cultivated area, while Jalgaon district contribute to 3.82 per cent of state geographical area (11.765 Lakh ha), gross cropped area 14.515 (Lakh ha) and net sown area was 8.03 (Lakh ha).

In agriculture and livestock production, natural resources *viz.*, soil, water and weather play an important role. All the agricultural practices from sowing to storage, marketing as well as in all livestock production practices weather and its coordinating factors play key role. Hence, it is important to manage these all practices according to changes in weather.

It is desirable that all possible efforts to be made to understand weather events and predict weather with maximum possible lead time so that the farmers can get sufficient time to cope with the situation. For this purpose, the study of rainfall characterization is very much important. This includes rainfall variability, commencement and withdrawal of monsoon and occurrence of wet and dry spells of different duration in crop period in general and critical growth stages in particular. The study of their interaction with the soil is very useful for the planning of various agronomical operations like seedbed preparation, manuring, sowing, weeding, transplanting, harvesting, threshing and drying etc.

The Jalgaon district lies in the north-west of Maharashtra between 20° to 21° North latitude and 74° 55' to 76° 28' East longitude and spreads across the Deccan Plateau in the rain shadow region of the Sahyadri mountain ranges on the northern most tip of the state of Maharashtra. The state Madhya Pradesh lies to the north, the Buldhana district of Maharashtra to the east, Aurangabad district of Maharashtra to south, Dhule and Nashik districts of Maharashtra to the west. To the north, we have the Satpura ranges and the river Aner goes from northern part which forms the natural boundaries to the district. Tapi river in central part of district also covers large area with its tributaries which is the main river of district. There are 15 tahasils in Jalgaon district viz., (1) Jalgaon (2) Jamner (3) Chalisgaon (4) Dhargaon (5) Bhusawal (6) Bodwada (7) Yawal (8) Raver (9) Muktainagar (10) Amalner (11) Chopada (12) Pachora (13) Erandol (14) Bhadgaon and (15) Parola.

The climate of the Jalgaon is generally dry except the monsoon period. The whole year climate of Jalgaon district may be divided into four periods as follows: (i) hot weather period from March to May (ii) monsoon period from June to September (iii) Post monsoon period from October to November (iv) Cold season from December to February. The May is the hottest month of the year. The mean maximum daily temperature reaches 42.5°C. The highest maximum temperature recorded at Jalgaon was 47.8°C. December is the coldest month with mean daily temperature 11.9°C. The cold waves coming from north Indian drop down temperature up to 2⁰C.

The district receives 81 per cent of rain from the South-West monsoon from June to September month. July being the month of the highest rainfall. The average rainfall of district is 698.09 mm. The central part of district comprising Jalgaon, Bhusawal, Jamner and Pachora tahasil get little more rain than in the rest of district. The rainfall is heavier in the hilly range of northern part of district. Hence, we can have three broad divisions as far as rainfall is concerned i) The northern zone receiving heavy and assured rainfall. ii) The central zone receiving moderate rainfall and iii) The southern zone receiving low, irregular and uncertain rainfall.

The soil of Jalgaon district is divided into five zones viz., (i) Western scarcity Zone - This zone receives low rainfall, which covered with light to medium soils. It is mainly found in Amalner, Dhargaon, Parola and Erandol tahasil. ii) Southern scarcity Zone - This zone with less rainfall is covered with medium soils. It is found in Chalisgaon, Bhadgaon, Pachora, Jamner and Bodwada tahasils. iii) Central Zone - The central zone with assured rainfall is covered with medium to deep soils of varying depths. This zone present on east to west strip on junction of Chopada, Amalner, Dhargaon, Yawal, Jalgaon and Bhusawal tahasils. iv) North East Zone – This zone with assured rainfall covered with medium soil. The zone covered central part of Chopada, Yawal, Raver and almost complete part of Muktainagar and Jalgaon tahasil except small north

part. v) Northern Zone – The zone with assured rainfall covered with light soil. It covers northern part of Chopada, Yawal, Raver and Muktainagar tahasil.

The almost part of district is covered with deccan trap which gives black soil called as ‘Regur Soil’. The patches of laterite soil recorded in the hills of southern part of district. The central belt of wide Tapi valley covers black alluvial soil which is highly retentive of moisture and loam overlying stratum of yellowish clay of good depth. The soil is mixed or overlaid with lime nodules along the bank of river.

Due to rainfall dependence and its variability almost crops are taken during *kharif* season as rainfed and with low area in *rabi* as irrigated crop. The major field crops taken during *kharif* season according to area are cotton, maize, sorghum, green gram, black gram, groundnut and pearl millet. During *rabi* season, sorghum, maize and wheat are taken as irrigated crop. The Jalgaon district is famous for Banana production in India contributes largest area in horticultural crop in district with few as acid lime, sweet orange and guava.

The net irrigated area of Jalgaon is about 2.13 Lakh ha (18.10%). The sources of irrigation for agricultural lands in the districts are either dug wells or canals. But about 97.6 % irrigated area is covered by open wells and only 2.3% is by canal irrigation. The study is undertaken to analyze rainfall pattern on the basis of rainfall to suggest crop and cropping patterns in different soil types. The rainfall analysis comprises of annual, seasonal, monthly and weekly variation, onset and withdrawal of monsoon, length of growing season and probability occurrence of rainfall of specific amount in a given period of time.

Soil moisture availability in Jalgaon is abundant during *kharif* season. However, the soil of district is black with considerable variation in texture and depth. The intra-seasonal distribution varies from year to year, so also the soil moisture after withdrawal of monsoon goes on depleting fast. Hence, utmost care should be taken while planning *rabi* crops on residual soil moisture. The information regarding different aspects of rainfall, its variability, onset and withdrawal of monsoon and severity of drought in each tahasil along with different soil types of Jalgaon district is very meager. Hence, it was necessary to undertake the characterization of rainfall for agricultural crop planning to the farmers of district. With these considerations, a systematic study was planned on “Characterization of rainfall for crop planning in Jalgaon district” with the following objectives:

- 1) To study rainfall characteristics of Jalgaon district of Maharashtra at tahasil level.
- 2) To compute annual, seasonal, monthly and weekly mean, standard deviation and coefficient of variation of rainfall at each tahasil level.
- 3) To estimate onset and termination/withdrawal of monsoon season in each tahasil and
- 4) To suggest crops and cropping pattern based on soil type and rainfall distribution in each tahasil.

2. REVIEW OF LITERATURE

Now a days, the population of world as well as India goes to increasing, hence to fulfill food requirement of human being, it is important to study the effect of different weather parameters on agricultural and livestock production. Out of all weather parameters rainfall is majorly affected on agriculture. It varies from place to place and time to time. The study of annual, seasonal, monthly and weekly rainfall variability and also its onset withdrawn and effect on drought occurrence is essential to manage the agriculture and livestock production.

It is desirable that all possible efforts to be made to understand weather events and predict weather with maximum possible lead time so that the farmers can get sufficient time to cope with the situation. For this purpose, the study of rainfall characterization is very much important. This includes rainfall variability, commencement and withdrawal of monsoon and occurrence of wet and dry spells of different duration in crop period in general and critical growth stages in particular. The study of their interaction with the soil is very useful for the planning of various agronomical operations like seedbed preparation, manuring, sowing, weeding, transplanting, harvesting, threshing and drying etc.

The present study is aimed at the above goals and for which the past pertinent literature was reviewed and presented under appropriate sub heads.

2.1 Rainfall Variability:

2.1.1 Annual Rainfall Variability:

Gaikwad *et al.* (1995) suggested the suitable sowing date for sunflower on rainfall probabilities. A field study was carried out to evaluate the performance of sunflower and sunflower + red gram (2:1) intercropping system sown according to rainfall probabilities for 5 successive years during *kharif* season on 30 cm soil depths and observed that the yield of sunflower and sunflower + redgram (2:1) intercropping was increased when crop was either sown during 24 MW or 25 MW.

Gaikwad *et al.* (1996) studied rainfall variability at Solapur station by using 29 years data (1963-1992). Potential Evapotranspiration values were estimated. Probability analysis was based on first order Markov Chain through which dry seeding was suggested in early June for *kharif* crops.

Barai *et al.* (2004) developed the rainfall intensity *Monograph* for Rahuri region from Inter Faculty Department (IFD) on water management. They analyzed the rainfall charts of 17 years of Rahuri in the form of annual maximum series of various duration *viz.*, 5, 10, 15 and 30 minutes and 1, 3, 6, 12 and 24 hrs. Percentage deviations in rainfall intensity values observed from -1.5 to 4.5 per cent which lies within accepted limit.

Dixit *et al.* (2005) studied the variability of rainfall in Konkan region. They collected daily rainfall data of 32 years (1972-2003) and analyzed for weekly, monthly, seasonal and annual rainfall. They revealed that rainfall at severe deficit was 13%. Similarly, chance of rainfall being moderately surplus by 31 per cent was higher than highly surplus (66%). Crops suggested were cashew nut, mango, coconut and aonla.

Mary *et al.* (2005) studied the rainfall pattern of Salur in Tamilnadu for forecasting the possible rainfall with more amount of reliability and predicted the cyclic changes by using Markov- Chain transition probability analysis showed that the period of severe drought occurred once in a seven years and the period of excess also occurred once in seven years.

Singh (2005) worked on rainfall variability and crop planning in Sabour region of Bihar. The daily rainfall data for 29 years (1972-2000) recorded at Bihar Agricultural College, Sabour (Bihar) were analyzed for mean, annual, seasonal, monthly and weekly periods. Markov Chain probabilities ($> = 20$ mm rainfall week) were also worked out. Fourteen years received above average rainfall with 41 per cent chance of getting more than normal rainfall. The mean sowing rains commence around 20th June. Initial probability of receiving 20 mm was more than 70 per cent from 26th to 34th standard meteorological week in *kharif*. Result indicated that the *rabi* season rainfall to be more suitable for crops like *rabi* maize, oilseed or pulses.

Bhakar *et al.* (2007) studied the rainfall analysis for drought estimation of Kota region by recording the daily rainfall data for the period of thirty five years used for computation of drought months and drought seasons. Analysis of the data showed that 17 per cent years were drought years, 20 per cent were abnormal years and remaining were normal years receiving rainfall between 470- 982 mm. There was a possibility of one drought year in a span of 6 years. It could be estimated that about 19 per cent of the total months during monsoon period were drought months.

Deka *et al.* (2008) studied the variability in rainfall and temperature regimes of the Brahmaputra valley of Assam. Long-term data on annual and seasonal rainfall, maximum, minimum and mean temperatures of the different stations were included in the analysis. The analysis showed that except Dibrugarh, Nagaon and Dhubri total annual rainfall was on the declining trend in all the stations.

Singh *et al.* (2008) made the rainfall probability analysis using Markov Chain model in Sabour region of Bihar. They observed that during 30 years (1972-2001), there were about 13 per cent drought, 10 per cent flood and 77 per cent normal years and among the drought years, South West monsoon rainfall was the lowest in the year 1977.

Gaikwad (2009) studied the daily tahasil wise rainfall characterization for last 30 years (1979-2008) of Jalna district and studied for inter seasonal, yearly, monthly and weekly variation,

its deviation from normal to correlation and found that annual rainfall ranged from 632.4 mm to 750 mm in tahasils, year to year variation was the highest in Ambad tahasil and the lowest variation in Jafrabad tahasil.

Rai and Singh (2009) studied rainfall variability for crop planning at Madhepura in Bihar. Daily rainfall data of thirty years (1974-2004) have been analysed for establishing the long term averages of weekly, monthly, seasonal and annual rainfall and its variability. The mean annual rainfall of Madhepura was 1546.3 mm spread over 84 rainy days with a standard deviation of 385.6 mm and coefficient of variation 24 per cent. Out of 30 years, 15 years received deficit rainfall from normal in the range of 6 to 41 per cent. Since, 1995 onwards, it was evident that none of the years has experienced drought (rainfall deficiency was not more than 20 per cent from normal). Maximum number (six) of years experienced moderate (deficiency, 20-30 per cent from normal) to large (deficiency, 30-40 per cent from normal) intensity of drought during the period of 1982-1994. Rainfall deficiency was more than 38 per cent in the years of 1986 and 1989. Since last 30 years, no disastrous drought occurred at Madhepura. The 1975 drought was one of severe drought with rainfall deficiency of 41 per cent.

Halikatti *et al.* (2010) studied annual and seasonal rainfall variability at Dharwad in Karnataka by rainfall data for the period of 1974 to 2009 for 36 years. The rainfall pattern and seasonal distribution was changed over time. The seasonal rainfall variability during the last 16 years (1994-2009) indicated that pre-monsoon season rains were deficit in 10 years (19.7 to 69.7 %) and excess in six years (20.7 to 44.1 %) as against the normal rainfall of 136.0 mm. Rainfall was deficit continuously from 1999 (53.2 %) to 2003 (84.2 %) indicated severe drought like conditions. The annual rainfall was normal during six years (1994 to 1998 and 2006), while excess during 2005 and 2007 to 2009 (21.6 to 41.9 %) and continuously six years severe deficit (upto 76.6 %) from 1999 to 2004 of which two years moderate drought (1999-2000), three years severe drought continuously (2001-2003) and one year (2004) slight drought.

Biradar *et al.* (2010) worked on analysis of annual and seasonal behaviour of Bhalki tahasil (Karnataka). The historical rainfall data of 34 years (1976-2009) of Bhalki tahasil were used to analyze the monthly, seasonal and annual variability of rainfall. The thirty four years average annual rainfall of the region was 874.7 mm with average rainy days of 51 days. In case of seasonal rainfall the per cent contribution to the total rainfall was 76.9, 13.8, 7.8 and 1.5 per cent for monsoon, post monsoon, summer and winter seasons respectively, with the lowest coefficient of variation in monsoon, post monsoon followed by summer and winter season. August was the wettest month with mean rainfall of 211.6 mm. The study also revealed that the coefficient of variation was lowest from June to October months.

Amrutha Rani and Shreedhar (2014) reported that rainfall patterns usually have spatial and temporal variability. This dissertation work was an analysis of variations and trends in rainfall for Belgaum district (Karnataka). Some parts of Belgaum district receive annual rainfall less than 750 mm and hence are drought prone. Studies on phenomenon of low rainfall in the district and statistical analysis of annual rainfall data from 42 rain gauge stations located in the district was carried out for data varied from 25 years to 33 years. The analysis was based on the series of tests designed to determine if the annual rainfall data is consistent, random and trend free. The trend in the data was determined by linear regression method and the different variability was determined for stations. The Standard Precipitation Index (SPI) method was used for drought analysis. The study concludes with the description of the structural characteristics and temporal and spatial variations of the annual rainfall data in Belgaum district.

Dhanawade (2016) worked on characterization of rainfall for Solapur district of Maharashtra. She found that amongst various tahasils, the annual rainfall ranged between 570 to 650 mm. The frequency distribution analysis for annual rainfall indicated that out of 35 years the normal rainfall was 24 years. 8 years were severe deficit rainfall showed narrow variations followed by NE monsoon and the highest variation in rest period of the year was from South west monsoon. The commencement of rainy season in the district was noticed in 24 MW and persistence of monsoon activities in the following weeks suggest strongly to initiate sowing operation in 24 MW onwards. The analysis showed that the more chance of occurrence of dry spell at 38 to 45 MW in all tahasils and the start of rainy season at probability of about 50 per cent rainfall ranged between 22 to 25 MW while the end of rainy season ranges between 42 to 52 MW for all tahasils.

Gangarde (2016) studied characterization of rainfall for Pune district of Maharashtra. She observed that amongst the various tahasils, the annual rainfall ranged between 650 to 750 mm. The year to year variations was the highest in Baramati tahasil while the lowest variation was noticed in Vadgaon Maval tahasil. The commencement of rainy season in the district was average and noticed in 30 to 39 MW and persistence of monsoon activities in the following weeks suggested strongly to initiate sowing operation in 22 MW onwards. The analysis showed that the more chance of occurrence of dry spell at 44 to 45 MW in all tahasils and the start of rainy season at probability of about 50 per cent rainfall ranged between MW 22 to 25 while the end of rainy season ranged between 42 to 52 MW for all tahasils.

Patil (2017) studied characterization of rainfall for Kolhapur district of Maharashtra. She observed that amongst the various tahasils, the annual rainfall ranged between 615.7 to 5662.3 mm. The year to year variations was the highest in Shirol tahasil while the low est variation was noticed in Bhudargad tahasil. The commencement of rainy season in the district was average and noticed in 30 to 38 MW and persistence of monsoon activities in the following weeks suggested

strongly to initiate sowing operation in 24 MW onwards. The start of rainy season at probability of about 50 per cent rainfall ranged between MW 24 to 25 while the end of rainy season ranged between 42 to 48 MW for all tahasils.

Shaikh *et al.* (2017 a) reported that average annual rainfall of Satara district was 1345 mm. It was varied from 519.2 mm at Phaltan to 5635.2 mm at Mahabaleshwar. Further, average annual rainfall recorded in various tahasils in descending order was 5635.2 mm at Mahabaleshwar, 1772.2 mm at Phaltan, 1645.3 mm at Javli, 1085 mm at Satara, 903.4 mm at Wai, 768.9 mm at Koregaon, 755.8 mm at Karad, 589.7 mm at Man, 579.4 at Khatav 550.9mm at Khandala and 519.2mm at Phaltan.

Shaikh *et al.* (2018 a) reported that average annual rainfall of Satara district was 1345.0 mm which was received in 56 rainy days with the highest of 69 rainy days during 2005 and the lowest of 47 rainy days during 2002. The average number of rainy days ranged from 73 days in Javali to 51 days in Karad. While, the mean rainy days recorded in different tahasils of Satara were 35 rainy days in Khandala, 39 rainy days in Khatav, 52 rainy days in Koregaon, 113 rainy days in Mahabaleshwar, 40 rainy days Man, 76 days in Patan, 33 rainy days in Phaltan, 63 rainy days in Satara and 52 rainy days in Wai.

2.1.2 Seasonal Rainfall Variability:

Raghavan (1964) studied the influences of the western ghat on monsoon rainfall of the coastal boundary of the peninsular India. He found that rainfall during the monsoon season usually increased from the coastal boundary towards the Western Ghats.

Deka and Nath (2000) worked on rainfall analysis for rainfed crop planning in the upper Brahmaputra valley zone of Assam. Daily rainfall data for 25 years (1974-1998) was recorded at Agromet Observatory of Assam Agricultural University, Jorhat. For seasonal rainfall analysis, three distinct crop seasons have been identified. These are summer (March to May), *kharif* (June to September) and *rabi* (October to February). The highest rainfall occurs during *kharif* season (1232.2 mm) followed by *summer* (478.6 mm) and *rabi* (220.4 mm) seasons. In this region, rainfall increased from January onwards and attains a flat peak during July and August and then falls reaching the lowest value (15.4 mm) in December. Mean monthly rainfall was the highest in July (394.5 mm). During the months of June to September the coefficient of variance of mean monthly rainfall was the least (16 to 20 per cent).

Gare *et al.* (2000) studied rainfall variability analysis at Gadhinglaj (Maharashtra) on the basis of 28 years rainfall data (1969-1996) for weekly, monthly, seasonal and annual rainfall at different probability levels. They concluded that *kharif* season was more assured than the *rabi* season and MW 29 was suitable for dry seeding in that area.

Islam *et al.* (2005) studied the spatial and temporal variation of rainfall in and around Bangladesh with the radar and rain gauge data. The occurrence of 21.00- 9.00 hr. LST rainfall was linked to local effects such as sea and land breeze circulation. The North Western part of Bangladesh was largely affected by pre monsoon clouds, while whole country was affected by the peak monsoon activities.

Parmar *et al.* (2005) studied climatic variability in Gujarat state of India. Historical data for 26 years (1976-2002) were collected and analyzed for annual and seasonal climatic variability of *kharif* and *rabi* in terms of standard deviation (S.D.) and coefficient of variation (C.V.) and four years moving average. They concluded that average of *kharif* revealed decrease in rainfall at S. K. Nagar, by (-30.97mm) unlike Sagdivi (+45.26 mm) and Anand (+17.29 mm).

Sahoo *et al.* (2008) carried out probability analysis of rainfall for Udhagamandalam. They collected the daily rainfall data of 43 years (1960-2002) for annual, seasonal and monthly analysis at different probability levels to obtain the rainfall distribution pattern. They observed that at 80 per cent probability level, the rainfall available in the first (May- Aug) and second (Sept-Nov) season are more than the water requirement of the crops which are grown in that region. In the third (Dec-April) season, the rainfall availability was not enough to support any crop without irrigation.

Singh and Shah (2008) studied the spatial temporal variability of rainfall, amount and number of rainy days, temporal variability of rainfall. The analyses showed that the seasonal rainfall during monsoon period typically showed higher inter annual variability and temporal variability.

Singh *et al.* (2009 a) worked on rainfall characteristics of North-West alluvial zone of Bihar by using rainfall data for the period of 1960-2005 to analyze the probability of occurrence of deficit or normal or excess rainfall. The result indicated that crop suitable period from June third week to October 1st week. During the study period of 46 years, there were about (12 years) 26 per cent deficit (9 years), 20 per cent excessive (and 25 years) and 54 per cent normal year. In the monsoon period of 46 years also, there were about 23 per cent of deficit, 24 per cent of excessive and 48 per cent of normal occurrences. The mean rainfall of 999.3 mm was received in *kharif* season contributed 83 per cent to total annual rainfall with coefficient of variation of 32 per cent and standard deviation of 315 mm indicated its dependability for post monsoon season the mean rainfall was 84.9 mm and contributed 7 per cent to the total annual rainfall summer rainfall also contributed substantial annual of 91.6 mm and contributed 8 per cent to the total.

Singh *et al.* (2009 b) studied climatic variability in Jhansi region of Uttar Pradesh. The daily rainfall and temperature data for 1969-2000 of Jhansi were analysed to know seasonal and annual variability. Three distinct crop growth seasons *kharif*, *rabi* and summer were characterized

for seasonal trends. The stable rainfall period was worked out. The annual and *kharif* rainfall showed a decrease in rainfall in recent decade.

Chand *et al.* (2010) studied rainfall data for the period of 34 years (1975-2008) of Jhansi in Bundelkhand agro climatic zone of U.P. They analyzed weekly, monthly, seasonal and annual probabilities at different levels of rainfall for suitable crop planning. The analysis revealed that 90.3% of the total annual rainfall is received during SW monsoon months (June- September) with high intensity causes moderate to severe erosion. Post monsoon or winter months (October to February) account 7.1% while pre monsoon or summer months (March -May) accounts 2.6% of total yearly rainfall. Analysis also showed that the frequency of drought has been increased since the 2000 onwards in the zone. The maximum amount of rainfall was received during August (286.0mm) and minimum during April (3.1mm). Occurrence of 70% of initial probability of a dry week from 1st to 24th MW and the conditional probability of wet week preceded by a wet week was also high from 26th to 37th week. The *kharif* season crops and their varieties may be chosen with the growing period to avoid moisture stress as well as In-situ moisture conservation practices undertaken. The sowing of rainfed crops in *rabi* season may be completed between 40th to 41st MW because subsequent week has rare chance to get rains. It was also indicated that the pulses and oilseeds whose average water requirement is 300mm could successfully be fulfilled during *rabi* season.

Hanumanthappa *et al.* (2010) studied annual and seasonal rainfall variability in coastal districts of Karnataka by using rainfall data of 25 years (1985-2009). The seasonal rainfall variability during the last 25 years indicated that pre-monsoon season rains were deficit in 14 years and excess in 11 years (16.9 to 206.8%) as against the normal rainfall of 183.2 mm. The result revealed that the rainfall pattern and seasonal distribution was not changed over time.

Ravindrababu *et al.* (2010) studied weekly, monthly and seasonal rainfall at Bengaluru in Karnataka. Daily rainfall data of Agromet Observatory at UAS, GKVK, Bengaluru (Karnataka) for the period of 1972-2009 was used for analysis. Mean rainfall during south west monsoon season (June to September) was 518.4 mm which accounted 56 per cent of the total annual rainfall with coefficient of variation 30.7 per cent. The number of rainy days in SW monsoon season was varied from 19 to 44 days with an average of 32 rainy days. During North-East monsoon period (October to December) the mean rainfall was 233.9 mm and it contributed 25 per cent to the annual rainfall with coefficient of variation of 55.7 per cent and standard deviation of 130.3 mm. Mean rainfall during pre monsoon period (March to May) was 162.2 mm which accounted 18 per cent of annual rainfall and winter mean rainfall was 11.3 mm which accounted one per cent of annual rainfall.

Powar (2017) studied characterization of rainfall for Sangli district of Maharashtra. She observed that amongst the various tahasils, the annual rainfall ranged between 352.2 to 1071.8 mm. The year to year variations was the highest in Jat tahasil while the lowest variation was noticed in Shirala tahasil. The commencement of rainy season in the district was average and noticed in 32 to 39 MW and persistence of monsoon activities in the following weeks suggested strongly to initiate sowing operation in 23 MW onwards. The start of rainy season at probability of about 50 per cent rainfall ranged between MW 22 to 24 while the end of rainy season ranged between 45 to 48 MW for all tahasils.

Shaikh *et al.* (2017 d) reported that the total rainfall received from SW monsoon season, June to September month and October recorded higher rainfall than remaining months. This rainfall coincides with reproductive stage of *kharif* as well as timely sowing of *rabi* crops. The average monthly rainfall variation was in the range of 422.9 per cent to 57 per cent in January and July month, respectively. The highest rainfall was received in the month of July is (391.1 mm) contributing 23.8 per cent with variation of 72.7 per cent of total rainfall in the year and was closely followed by the month of August to an amount of 355.9 mm with 18 per cent contribution.

Tan *et al.* (2017) studied the modelling of a homogeneous hidden Markov model (HMM) on the northeast rainfall monsoon using 40 rainfall station in Peninsular Malaysia for the period of 1975 to 2008. A six hidden states HMM was selected based on Bayesian information criterion (BIS) and every hidden state has district rainfall characteristics. Three of the states were found to correspond by wet condition; while the remaining three states were found to correspond by dry conditions. The six hidden states were found to correspond with associated atmospheric composites. The relation between El Nino-Southern Oscillation (ENSO) and the sea surface temperature (SST) in the Pacific Ocean are found regarding inter annual variability. The wet (dry) states were found to be well correlated with a Nino 3.4 index which has to used characterize the intensity of an ENSO event. This model is able to assess the behaviour of the rainfall characteristics with the large scale atmospheric circulation; the monsoon rainfall is well correlated with the El Nino-Southern Oscillation Peninsular Malaysia.

Shaikh *et al.* (2018 c) reported that more number of rainy days were observed in South-west and North-east seasons and negligible during winter and summer season in Satara district of Maharashtra. However, mean number of rainy days received from South-west monsoon was 46 rainy days which contributed 77 per cent of annual rainy days for 55 years, while the rainy days from North-east monsoon were rainy 11 days contributed 17 per cent and the rainy days from Summer and Winter showers were 4 days for each season contributed 6 per cent.

2.1.3 Monthly Rainfall Variability:

Jadhav *et al.* (1999) studied rainfall probability analysis for crop planning in scarcity zone of Maharashtra. They collected historical data of rainfall for 30 years (1966-1995) from nine different stations of scarcity zone. Rainfall at various probability levels for weekly, monthly, seasonal and annual were estimated. Trends calculated separately for these stations. They concluded that MW 24 and MW 38 had the highest probability of rainfall. This helped in sowing of *kharif* and *rabi* crops for dry seeding.

Annual and monthly rainfall in Cambodia were analysed with the aim to aid farmers when making choices as to which crops to grow apart from rice. Daily records of rainfall data in the four provinces of Battambang, Kampong Cham and Takeo were analyzed to calculate the monthly rainfall totals, determine the variability in annual rainfall, determine if the total rainfall in the month of March or April could give an indication of the potential rainfall for the remaining season and determine if the drought periods in the June and July are consistent in each year and if they may be predicted (Anonymous, 2004).

Saha and Mishra (2005) analyzed the rainfall data of 15 years of Meghalaya at various probability levels *viz.*, 5, 11 and 13 for maximum number of drought, normal and surplus months in a year, respectively. They concluded that the drought periods were concentrated in between November - March, whereas, the surplus periods were from April- October. The surplus water should be used during the drought periods.

Hundekar (2007) studied the characterization of rainfall of Latur district for crop planning. The daily rainfall data of different tahasils were collected for the period of 1978 to 2006. Using this data, he has studied the statistics of rainfall at tahasil level and estimated variability in respect of weekly, monthly, seasonal and annual rainfall. The initial and conditional probability, the length of growing period ranged between 18-19 weeks. Crop needs to be cultivated by adopting suitable available moisture conservation measures.

Reddy *et al.* (2007 b) studied rainfall variability and its impact on agricultural production in north Telangana regions of Andhra Pradesh. They collected and analyzed district wise monthly rainfall data of 40 years (1963-2002) and concluded that the decrease in rainfall trends in Adilabad, Nizamabad and Medak. Dependable rainfall at September decreased at all districts except Khamm that affected at flowering to yield stage. Increased dependable rainfall in the month of October helped in timely sowing of *rabi* crops.

Bora *et al.* (2008) studied rainfall analysis for drought investigation in central Brahmaputra valley zone of Assam. Daily rainfall of 36 years were collected and analyzed to investigate its behavior on monthly and weekly basis. Higher probability of drought was observed in November, January and February.

Krishnakumar and Prasad Rao (2008) studied the trends and variability in North East monsoon rainfall over Kerala. They observed that the monthly rainfall over Kerala showed an increasing tendency during October and November with a decreasing in December such trend was more evident since 1961 onwards. The monthly rainfall range as well as its variability was less during excess rainfall years when compared to that of deficit rainfall years.

Shaikh *et al.* (2017 b) reported that the total rainfall received from SW monsoon season, June to September month and October recorded higher rainfall than remaining months. This rainfall coincides with reproductive stage of *kharif* crop as well as timely sowing of *rabi* crops. The average monthly rainfall variation was in the range of 422.9 per cent to 57 per cent in January and July month, respectively. The highest rainfall was received in the month of July is (391.1 mm) contributing 23.8 per cent with variation of 72.7 per cent of total rainfall in the year and was closely followed by the month of August to an amount of 355.9 mm with 18 per cent contribution.

Suvarna (2017) studied characterization of rainfall for Satara district of Maharashtra. She observed that amongst the various tahasils, the annual rainfall ranged between 519.5 to 5635.2 mm. The year to year variations was the highest in Khatav tahasil while the lowest variation was noticed in Wai tahasil. The commencement of rainy season in the district was average and noticed in 29 to 33 MW and persistence of monsoon activities in the following weeks suggested strongly to initiate sowing operation in 21 MW onwards. The start of rainy season at probability of about 50 per cent rainfall ranged between MW 17 to 20 while the end of rainy season ranged between 43 to 46 MW for all tahasils.

Yi He *et al.* (2017) observed that highly concentrated precipitation, where a large percentage of annual precipitation occurs over a few days, may include a high risk of flooding and severe soil erosion. Thus, areas with severe erosion such as the Loess Plateau in China are particularly vulnerable to highly concentrated precipitation events due to climate change. In this study, we investigated spatial and temporal patterns in the concentration of rainfall in the Middle Yellow River (MYR) from the last 56 years (1958–2013). We used daily and monthly precipitation data from 26 meteorological stations in the study area to calculate the precipitation concentration index (PCI) and the concentration index (CI). The southern and northern parts of the MYR were characterized by a lower CI with a decreasing trend, while the middle parts had a higher CI with an increasing trend. High PCI values occurred in the southern MYR, while lower PCIs with a more homogenous rainfall distribution were found mainly in the northern parts of the MYR. The annual PCI and CI exhibited positive trends at most stations, although only a minority of stations had significant trends ($P < 0.05$). At seasonal scales, CI exhibited significantly increasing trends in winter at most stations, while a few stations had significant trends in the other three seasons. These

findings provide important reference information to facilitate ecological restoration and farming operations in the study region.

Shaikh et al. (2018 b) reported that the average rainy days of all the tahasils of Satara district were 57 rainy days with 1882 per cent variation. The average highest number of rainy days were 14 rainy days in the month of July, followed by 13 rainy days in August, June and September and 10 days in October. While the least number of rainy days *i.e.* 1 and 2 days were observed in rest of all the months for the district.

2.1.4 Weekly Rainfall Variability:

Hargreaves (1975) defined dependable precipitation as an amount of rainfall normally equal or exceed for three-fourth of the time. It was observed that 75 per cent statistical probability of occurrence or exceeds. Mean rainfall data has little importance in *rainfed* agriculture. It gives only the trend of certain climatic pattern and can be useful as a tool to indicate agroclimatic homogenous zones, to some extent, but does not give any information on rainfall variability affecting the crop production.

Sarkar *et al.* (1982) studied the probability of rainfall within short period in dry farming tract and drawn useful information for knowing the climate potential for agricultural development and evolving suitable cropping pattern.

Viramani *et al.* (1982) studied the rainfall probabilities of some selected locations of semi arid tropics in India and concluded that proper knowledge of probability of rainfall for specified area was of great importance because of economic involvement of rain sensitive operations.

Samui (1994) worked on the mean weekly rainfall and its rate of change at Tadong and Gangtok in Assam. He has analysed to fix dates of onset and withdrawal of south west monsoon. The study attempted to analyse broad aspects of rainfall precipitation distribution during the four seasons. The study was based on data of 12 stations and of varying period of 4 to 25 years and concluded that the rainfall over mountainous slope was found monomodal with a maximum in July-August. Rainfall in the valley shows striking difference in patterns even at short distance (4 km) and situated at a higher altitude.

Sahane and Jadhav (1998) studied the rainfall probabilities at Vadgaon Maval by using 27 years data in which majority of weeks recorded more than 50 per cent probability receiving more than 25 mm rainfall and observed that out of 52 weeks, 12 weeks recorded more than 50 per cent initial probabilities for 25 mm rainfall followed by 8, 2 and 1 weeks for more than 50, 75 and 100 mm rainfall, respectively.

Mane *et al.* (2001) analyzed the meteorological drought by recording the daily rainfall data. They worked out the rainfall values of the weekly rainfall of 24th to 39th meteorological weeks, monthly, seasonal and yearly rainfall and concluded that during 25 years period, there were 2 years when droughts were experienced and severity of drought was nearly common during both the years of 1986 and 1995.

Ugale (2007) studied the characterization of rainfall of Beed district for crop planning. His analysis included weekly, monthly and seasonal variations such as standard deviation and coefficient of variation of each tahasils for 32 years. In addition to previous crops, he suggested vegetable crops (tomato, onion, methi, and pea) pulse crops, flower crops (rose, chrysanthemum and marigold) to be included.

Sheth and Shete (2008) carried out a study on daily normal rainfall pattern for Dahod district on Gujarat. They collected rainfall from 1961-2000 for studying local factor, which affected on crop production like distance from equator etc. Analysis revealed that daily normal rainfall increased from East to West.

Shaikh *et al.* (2017 f) reported that the availability of water for crops in a season depends on the distribution and variability of weekly rainfall. Hence, from crop management point of view, week is to be considered the ideal period for crop planning, scheduling farm operations on land use operations and therefore the weekly rainfall analysis of each tahasil were worked out and presented in Table1. The average of weekly rainfall of Satara district was 1344.9 mm. The highest rainfall was observed in 30 MW starting from 20 MW, whereas, ending during 46 MW. However, it is decreased slowly from 43 MW. The variation of the highest rainfall was 223.4 per cent. After the 43 MW, rainfall decreased sharply.

Vende (2017) studied characterization of rainfall for Ahmednagar district of Maharashtra. She observed that amongst the various tahasils, the annual rainfall ranged between 446.9 to 702.1 mm. The year to year variations was the highest in Pathardi tahasil while the lowest variation was noticed in Shrigonda tahasil. The commencement of rainy season in the district was average and noticed in 36 to 39 MW and persistence of monsoon activities in the following weeks suggested strongly to initiate sowing operation in 22 MW onwards. The start of rainy season at probability of about 50 per cent rainfall ranged between MW 21 to 23 while the end of rainy season ranged between 41 to 48 MW for all tahasils.

2.2 Crop Planning:

2.2.1 Crop Planning Based on Annual Rainfall:

Sharma *et al.* (1996) analyzed the daily rainfall data for 1969-93, recorded at Regional Agricultural Station, Diphu (Assam) for annual, seasonal, monthly and weekly periods and suggested suitable *rainfed* cropping system for the hill zone of Assam.

Saikia *et al.* (2007) studied trend of rainfall and temperature change at Umaiam (Meghalaya). Rainfall data of 1983-2002 were analyzed. It was observed that all trends equations have negative intercepts, indicated decrease in amount of rainfall over time.

Jain and Kumar (2012) observed that most of the basins had the same direction of trend in rainfall and rainy days at the annual and seasonal scale. Trend analysis of rainfall data of 135 years (1871-2005) indicated no significant trend for annual, seasonal and monthly rainfall on all-India basis. Annual and monsoon rainfall decreased and pre monsoon, post monsoon and winter rainfall increased over the years with maximum increase in the pre monsoon season. Monsoon months of June, July and September witnessed decreasing rainfall, whereas, August showed increasing trend on an all-India basis. Further analysis on sub-divisional basis indicated that half of them have increasing trend in annual rainfall but for only three sub-divisions, namely Haryana, Punjab and coastal Karnataka, this trend was statistically significant. Only the Chhattisgarh sub-division had significant decreasing trend out of the 15 sub-divisions showing decreasing trend in annual rainfall. All five regions showed non-significant trend in annual, seasonal and monthly rainfall for most of the months.

2.2.2 Crop Planning Based on Seasonal Rainfall:

Singh *et al.* (2005) published rainfall variability and crop planning in Sabour region of Bihar. He collected and analyzed the twenty-nine years rainfall data (1972-2000) for mean annual, seasonal, monthly and weekly period and suggested crops like *rabi* maize, oilseed or pulses for stabilized production.

Rai *et al.* (2008) analyzed rainfall data of Bundelkhand region of central India for 1939-1996. Study suggested to sow the *khari* rainfed crops such as groundnut, black gram, green gram and sesamum during 27 MW. Soil moisture reserve was not enough to sow any crop in *parwa* and *rakar* soil type.

Gaikwad (2009) studied the daily tahasilwise rainfall characterization for last 30 years (1979-2008) of Jalna district. The study revealed that the monsoon season was very much ideal for agricultural enterprise in the district. The commencement of rainy season in the district was average and noticed in 24 MW and persistence of monsoon activities in the following weeks

suggested strongly to initiate sowing operation in 24 MW onwards. Further it was observed that the onset of monsoon was early during 22 MW to timely 24 MW and late onset 25 to 28 MW and withdrawal was early during 30 to 34 MW or late during 43 to 44 MW upto 52 MW in some cases. Study also revealed that the annual rainfall was the highest in Jalna tahasil and the lowest in Bhokardan tahasil. In South West monsoon, 81 to 87 per cent of rainfall was received while, remaining 11 to 14 per cent from North-East monsoon. Further, also observed that July and August months received maximum rainfall which was good for *kharif* crops and timely sown *rabi* crops.

Guhathakurta and Sazi (2013) reported that rainfall occurring from January to May in Maharashtra has fall down over 100 years. Vidharbha region was recognized as low rainfall area due to climate change, there is Vidharbha region increased over 100 years study. The trend of receiving total annual rainfall in short period (*i.e.* length of monsoon decreased) was observed in Marathwada region. It means the decreasing trend of rainy days was observed regionally and mixed trend (*i.e.* decreasing and increasing) was observed intra districally *i.e.* within the district.

2.2.3 Crop Planning Based on Monthly Rainfall:

Kar (2002) collected daily rainfall data (1966-1995) at 5 coastal stations of Orissa for computing seasonal distribution of rainfall, coefficient of variability of monthly rainfall and probability of monthly and weekly rainfall. Estimations were carried out by Markov chain probability model and incomplete gamma distribution. They suggested high value *rabi* crops like groundnut, sunflower and wheat with assured supplemental irrigation during *rabi* season starting from first week of November can be taken.

Mahale *et al.* (2008) estimated the probability of monthly and yearly drought by using rainfall data and suggested crop plan for Dapoli region. The region experienced very less chance of drought with a probability of having at least three years out of ten years as drought years, the soil moisture conservation and rain water harvesting during monsoon season were found the best options for maximizing the crop production in the region.

2.2.4 Crop Planning Based on Weekly Rainfall:

Bhatia *et al.* (1975) analyzed 20 years data on distribution of rainfall of Rehmankhara (Luknow), Uttar Pradesh and reported that weekly rainfall were more important and relevant than monthly or yearly rainfall for selection of suitable crops and their cultivars for cultivation in monsoon season. They observed probability of drought occurrence was once in 10 years.

Bhattacharya and Parikh (1987) analyzed daily data for 54 years (1927-1980) of Navsari region (Gujarat) to find out the weekly expected rainfall at different percentages of chance or being exceeded for crop planning and irrigation scheduling.

Budhar and Gopalswamy (1988) suggested improved cropping system for Barur tract of Dharmapuri district in Tamil Nadu on the basis weekly of rainfall alone.

Chakraborty and Chakraborty (1990) studied rainfall and its impact on cropping pattern in Hoogly district of West Bengal. Probability of having a specified amount of 20 mm rainfall per week (one third of the potential evapotranspiration (PET) of the region) and a water balance approach was found quite effective to assess the water availability period for crop planning under rainfed condition.

Budhar *et al.* (1991) studied rainfall based cropping system in Palacode tahasil of North Western region of Tamil Nadu and observed that the P/PET ratio provided a good measure of crop suitability. Further, based on this ratio, a climatic index was developed and the values were super imposed on soil map to identify local drought prone area and classified them as mid, moderate or severe.

Subudhi *et al.* (1996) computed dependable weekly rainfall at 40, 50, 60 and 70 per cent probability levels for Bhadarh and Balasore districts of Orissa. Variation of mean annual rainfall, coefficient of variation and standard error were calculated. He observed that rainfall probability at 60 and 70 per cent may be assisted in crop planning and irrigation scheduling, respectively.

Tomar *et al.* (2002) suggested cropping pattern in vertisol based on monsoon period rainfall analysis of Indore district of Madhya Pradesh by collecting the daily rainfall values for 20 years for computing rainfall probability which were used for computing minimum assured rainfall for each period. They concluded that rainfall distribution was highly uneven over all pentads and fluctuate without any trend and suggested that the primary tillage operations can be started during the 1st pentad (15th Jun- 19th Jun), seedbed preparation and sowing of rainy season crop done in 4th pentad (30 Jun- 4 July).

Sahu (2008) studied the characteristics of weekly rainfall pattern at Junagarh in Saurashtra region for the period of 32 years. He observed that the highest average rainfall has occurred during 29th MW and the lowest during 34th week. The probability of getting any amount of rainfall during rainy period from 25th – 37th MW was more than 70 per cent. The stable period of rainfall was only 5-6 MW, falling in the month of July and August.

Subhash *et al.* (2011) studied *nakshatra* based rainfall variability, trends and its influence on rice-wheat production- A case study over two sites in Bihar (India). An attempt was made to study the variability and trends of during nakshstra periods for two sites, Patna and Samstipur of Bihar state. A significant increasing trend of 0.965 mm y⁻¹ and decreasing trend of -0.857 mm y⁻¹,

respectively, have been noticed during *Pushya* and *Hasta* at Patna. However, a significant increasing trend of 1.536 mm y^{-1} and decreasing trend of -0.774 mm y^{-1} , respectively have been noticed during Aridhra and Hasta at Samastipur respectively.

Chinchorkar *et al.* (2012 a) analysed daily rainfall data of 30 years (1972-2002) of different 20 rain gauge stations from the scarcity zone of Maharashtra. Weekly actual rainfall was considered for calculating Moisture Availability Index (MAI). The wet and dry spells were calculated by Markov Chain model. The arrival and departure of monsoon were decided by weekly rainfall frequency distribution method. It was suggested to grow grasses and dry land horticulture *viz.*, custard apple, pomegranate etc. on shallow soil in addition to present cropping pattern. Similarly, in medium and deep soils during *kharif* season sunflower, pearl millet + pigeonpea, castor, groundnut etc. were suggested. During *rabi*, sunflower, safflower, *rabi* sorghum, gram etc. were suggested with the provision of supplemental irrigations. Fodder sorghum in *kharif* and safflower in *rabi*, pearl millet in *kharif* and gram in *rabi*, black gram in *kharif* and sorghum in *rabi*, greengram in *kharif* and sunflower in *rabi*, cowpea for fodder in *kharif* and sunflower in *rabi* were suggested.

Chinchorkar *et al.* (2012 b) studied the daily rainfall data for the period of 13 years (1989-2001) of different 15 rain gauge stations from the sub montane zone of Maharashtra. Average weekly rainfall of all stations was calculated from the daily rainfall. The weekly assured rainfall values at 50 and 75% probability levels were computed by incomplete gamma distribution. The wet and dry spells were calculated by Markov Chain model. The onset and withdrawal of monsoon were decided by weekly rainfall frequency distribution method. From the assured total rainfall at 50 to 75 per cent probability it is clear that the maximum rainfall was received during the month of July and August especially in 28, 29 and 30 MW.

Pali *et al.* (2015) worked on daily rainfall data for 20 years (1994-2013) collected from Durg, Dhamdha and Patan blocks of Durg district of Chhattisgarh and other climatic data on minimum and maximum temperatures, relative humidity and evaporation for the same period (1994-2013) were collected from Durg block only. Using rainfall and evaporation data, weekly and seasonal mean rainfall, expected rainwater availability at given probability levels and ET demands of the rice crop at different growth stages were estimated and analyzed. This analysis showed that a severe drought situation may occur at all the blocks of Durg district. Thus, supplemental irrigation is essential at all the study blocks to obtain good rice yields.

2.3 Crop Planning on The Basis of Climatic Parameters:

Murthy (1976) suggested cropping pattern for different districts in Maharashtra. In Ahmednagar, water availability period was short and area was reported to be appropriate for pearl

millet. Pearl millet was also suggested for *kharif*, on shallow soils in Sangli and Aurangabad. In some parts of Ahmednagar district, *rabi* sorghum was suggested on medium deep soils where longer periods of water availability were observed. *Rabi* sorghum was also suggested in Sangli, Aurangabad and Beed districts on medium deep to deep soils. The results were fair to good when the soil moisture profile was 15-20 cm in early September. There was possibility of taking second crop of gram or safflower after sorghum at these places.

Kulandaivelu (1984) computed weekly totals by fitting incomplete gamma distribution and by using the daily precipitation data of Coimbatore center for a period of 70 years. The assured weekly rainfall amounts with different probability levels and the probability of receiving a given amount of rainfall were also worked out. The data indicated likely commencement of rains, period of drought, length of growing season and end of growing season. Based on the assured rainfall at 50 per cent probability level, suitable cropping systems were suggested for Coimbatore.

Biswas and Phadtare (1995) computed rainfall probability at different levels for 16 stations of Konkan region by fitting gamma distribution model to weekly rainfall and suggested a suitable cropping pattern based on rainfall probabilities, soils and existing cropping pattern of the region.

Rao *et al.* (1988) assessed the probability of receiving adequate rainfall for successful crop establishment by using daily rainfall data for Anantapur, Nandyal and Lam for 1969-1984. The implications for crop production were discussed and the probabilities of receiving a minimum monthly rainfall of 50, 75 and 100 mm at each location were calculated at different probability levels.

Biswas *et al.* (1989) computed weekly-assured rainfall of 10 to 90 per cent for 103 stations of Tamilnadu by fitting incomplete gamma distribution. This assured rainfall was used to demarcate the dry farming tract of Tamilnadu into various homogeneous rainfall zones as assured rainfall distribution, at different levels, drought prone area and a high assured rainfall pattern zone.

Singh *et al.* (2005) studied characterization of rainfall of Bhilwara region for crop planning. The daily rainfall data from 1960 to 2001 were analyzed to determine the onset, withdrawal, length of rainy season and its variability and dry spell periods in Bhilwara. The duration of rainy season ranged from 5 to 27 weeks and suggested off season and primary tillage operations may be started at the 24th week, while crop can be sown at the 27th week.

Manorama *et al.* (2007) carried out study on rainfall analysis and crop planning for the Nilgiris (Tamil nadu). Weekly, monthly, seasonal and annual study was carried out at different probability levels. He suggested potato, cabbage, carrot etc can be taken up in the 3rd week of April and the second crop can be planted at end of August rotating among these vegetables.

Goswami *et al.* (2008) analyzed the long term rainfall data for Sali rice season of Jaintia Hill district to estimate expected weekly rainfall at various probability levels. Based on expected

rainfall at 50 and 75 per cent probability level and water requirement, a crop calendar for Sali rice has been prepared for the district and suggested that the 22nd and 24th MW was best for sowing or transplanting.

Kothari *et al.* (2008) studied approach of rainfall analysis for crop planning under *rainfed* regions. The weekly meteorological data recorded at Dry land farming Research Station, Bhilwara for the period of 20 years (1985-2004) were used. They gave two approaches “Meteorological” and “Onset of monsoon”, which were used for selection of crops and cropping system in different years to harness more profit per unit of rainfall.

Maniyar *et al.* (2008) studied crop and cropping pattern on the basis of rainfall for Marathwada region of Maharashtra state. The block level rainfall data were analyzed. The length of growing season was in between 17-21 weeks. Crops and cropping system suggested by them were long duration –Cotton and red gram, short to medium *kharif* - Green gram, Black gram, Soybean, Sorghum, *rabi*-Sorghum, Safflower and Bengal gram under *rainfed* condition.

Ghosh (2008) collected 12 years data (1981-1992) of weekly rainfall from Raghunathpur, Purulia of red and lateritic soil zone of West Bengal. Markov Chain model was used for *kharif* season crop planning. Weekly, monthly, annual data was analyzed at different probability levels. The study reveals that dry and wet sowing of *kharif* paddy, the dominant crop of the region could be started from MW 24th and MW 25th.

Patel *et al.* (2008) studied annual and seasonal rainfall variability in different districts of Chhattisgarh in Central India. The variability analysis was carried out by using the daily historical data of 30 years (1951-1980). They concluded that cultivation in northern hill Bastar plateau and some of the district in Chhattisgarh plain zone while some at the district need crop diversification.

Kumar (2008) studied characterization and probability of rainfall for crop planning in Chotanagpur plateau. They collected 50 years data (1965-2005) for study. Variability found maximum (139%) in N-E monsoon and minimum (45.2%) in SW monsoon. Frequent droughts affected *kharif* crops. Probability of getting 50 mm rainfall was noticed during MW 26 to MW 38.

Sheoran *et al.* (2008) made rainfall analysis and suggested crop planning in lower Shivalika foot hills of Punjab. They recorded the daily rainfall data of Punjab for 26 years for long term averages of annual, seasonal, monthly and weekly rainfall and its temporal variability. They observed that there was an ample scope for rain water harvesting from July to September which can be utilized as crop saving irrigation as well as pre-sowing irrigation for succeeding *rabi* crops which are generally sown on residual soil moisture.

Singh *et al.* (2008) studied the rainfall distribution pattern and crop planning at Pusa in Bihar by collecting the daily data of fifty two years for establishing the long term averages of weekly, monthly, seasonal and annual rainfall and its variability. They observed that the average

duration of the rainy season was from 26th to 40th MW. Pre monsoon rains at 75 per cent probability level can be utilized for seedbed preparation and at 50 per cent probability level summer crops like cow pea and black gram could be grown successfully.

Solanki (2008) collected daily rainfall data for 36 years (1971-2006) and other parameters for twenty-five years (1982-2006). This data were analyzed for mean, annual, seasonal, monthly and weekly periods. Extremes of other weather parameters and trends of temperature in relation to rainfall were also worked out. They revealed that off-season tillage and primary tillage may be started from 23 MW and sowing may be started from 27 MW.

Talathi *et al.* (2008) studied the rainfall characteristics and crop planning with reference to rice in Konkan. They observed that very small variation in the length of rainy season which fairly useful for deciding crops and cropping enterprises and suggested to grow *rainfed* rice in wet season and excess rainwater utilized for life saving irrigation during the year of early withdrawal of monsoon rains.

Gaikwad (2009) studied the daily tahasil wise rainfall characterization for last 30 years (1979-2008) of Jalna district. The study revealed that the start and end of rainy season by forward and backward accumulation, the start of rainy season at probability of about 50 per cent rainfall ranged between 22 to 25 MW while the end of rainy season ranged between 42 to 52 MW for all tahasils.

Shaikh *et al.* (2017 c) reported the availability of water for crops in a season depends on the distribution and variability of rainfall. Hence, from crop management point of view, onset and withdrawal of monsoon is to be considered the ideal for crop planning, scheduling farm operations on land use operations and therefore the onset and withdrawal pattern of monsoon of each tahasil were worked out and presented in Table1. Onset and withdrawal of Satara district mean start of rainy season is 24 MW in most of the tahasils and early onset is at 23 MW in all the tahasils. While late onset observed from 25 MW to 26 MW. Mean termination of rainy season was noted in 42 MW to 48 MW. Early termination was observed during 41 MW to 43 MW in all the tahasils while late termination observed during 49 MW.

Shaikh *et al.* (2017 e) reported the average number of drought years of district for No drought, moderate drought and severe drought were 45, 8 and 2 and their contribution 82, 15 and 3 per cent, respectively. The information regarding different aspect of rainfall, like severity of drought in each tahasil along with the different soil types of Satara district is very meager. Hence, it was necessary to undertake the characterization of rainfall for agricultural crop planning to the farmers of district. With these considerations, a systematic study was planned on meteorological drought pattern in different tahasils of Satara district.

2.4 Crop Planning According to Soil Properties:

George and Krishnan (1969) attempted for assessing the water availability periods based on climatic and soil conditions.

Raman and Murthy (1971) attempted for assessing the water availability periods based on climatic and soil conditions.

Ambulgekar (1995) studied the fertility status of soils of Latur and Osmanabad district and reported that available nitrogen content in deep black and medium black soils were varied between 160 to 311 kg/ha and 123 to 231 kg/ha with an average values of 201 & 188 kg/ha, respectively.

Woldeamlak *et al.* (2003) Soil quality mainly depends on the response of soil to different land use system and management practices, which may often modify the soil properties and hence the soil productivity. Effect of land use system on soil properties provides an opportunity to evaluate sustainability of land use system and thus the basic process of soil degradation in relation to land use, and hence the soil and crop management must be given high research priority.

Nandagoudar *et al.* (2004) conducted a field experiment at Agricultural Research Station, Gangawati (Karnataka) to study the effect of tree species alone or in combination with grasses on physical properties of a saline soil. For this study they planted six tree species and napier grass in 1991 and physical properties were determined during 1995-96. Thus, they concluded that the soil bio-physical characteristics such as porosity, infiltration rate, hydraulic conductivity and aggregate stability improved under different tree cover. Bulk density and erodibility of soil decreased due to improvement in organic carbon status.

Geetha and Balagopalan (2005) carried out study in the South Indian moist deciduous forest and teak plantation belonging to two age groups of teak plantation *viz.*, 21-30 years and 31-40 years in the Vazhachal Forest division, Kerala. They concluded that the bulk density and particle density were greater than those in the natural forest. The water holding capacity and pore space were decreased. There was not much difference in soil pH values. Within the teak plantation, it was observed that bulk density and particle density increased while gravel, pore space and water holding capacity decreased with the age of the plantation. The plantation activities adversely affected the soil physical properties.

Reddy *et al.* (2007 a) conducted a field experiment on alluvial soils to study the effect of different organic manures along with inorganic fertilizer on physical, physico-chemical and chemical properties of alluvial soil and yield of sugarcane during 1994-96 on farmers field of Kovur Sugar factory area of Nellore district (Andhra Pradesh) and concluded that application of poultry manure along with inorganic fertilizer resulted in higher cane yield in plant crop, whereas, FYM along with inorganic fertilizers resulted in the highest cane yield in ratoon crops.

Rudramurthy *et al.* (2007) studied chemical properties of soils under different land use system in Shimoga district of Karnataka at Zonal Agricultural Research Station, Navile, Shimoga, UAS, Bangalore and concluded that both the soil reactions and lime potential were the lowest, while the exchangeable aluminium was the highest in the soil under tobacco land use system and soil under mixed forest land use system recorded higher fixation of both potassium and phosphorus than the soils under cultivated land use system.

Shinde (2007) studied physico-chemical properties and nutrient available of soils of Udgir and Deoni tahasils of Latur district for this purpose 200 representative soil samples were collected from 40 randomly selected villages of Udgir and Deoni tahasils from each village five soil samples were collected and concluded that the soils were clayey in texture. The soil pH of Udgir tahasil was ranged from 7.00 to 8.79 while in Deoni tahasils the soil pH was varied from 7.00 to 8.90.

Singh *et al.* (2007) studied the effect of continuous cropping for twenty years on some properties of the intensively cultivated alluvial soils and nutrient indexing of rice. Soil samples were collected after wheat harvest from a rice-wheat cropping system of an intensively cultivated Nabha soil series in Punjab for this study. The result revealed that long term application of chemical fertilizer to rice and wheat crops along with good quality of irrigation water did not deteriorate pH and electric conductivity (in terms of acidity/sodicity and salinity) of Nabha soil.

Gable *et al.* (2008) conducted a field experiment in *kharif* and *rabi* season of 2005-06 to study the effect of integrated nutrient management in maize-chickpea cropping system on physico-chemical properties of soil. Result revealed that physico-chemical properties of soil like pH, electrical conductivity, bulk density, field capacity and permanent wilting point were improved significantly due to application of nitrogen through *Leucaena* lopping and use of *Azotobacter* for seed treatment.

Khanikar and Nath (2008) studied soil climate analogues of rapeseed, mustard, potato and lentil in Assam and concluded that North bank of the Brahmaputra was suitable for rapeseed and mustard whereas, in the South bank suitable agroclimatic environments for the crop are comparatively few potato can be grown in most parts of the state excepting the major part of Hill zone, Barak Valley zone and Southern parts of Kamrup and Goalpara districts.

Gaikwad (2009) studied the daily tahasilwise rainfall characterization for last 30 years (1979-2008) of Jalna district. The study revealed that the probability analysis of occurrence of dry and wet spells provided the relevant information for different intercultural operations and can be useful for farm planning. The data studied in the project revealed that the probability of occurrence of 2 weeks dry spell was the highest in 44 MW while the probability of occurrence of 3 weeks dry spell was the highest in 43 MW and the probability of occurrence of 4 weeks dry spell was the highest in 42 MW. So crops like maize can be sown dry which will be germinated just after the

rains and can save the time of land preparation. Further based on the rainfall characterization and depth of soil, the cropping pattern was suggested according to soil depths as less than 7.5 cm (Pastures and Rainfed fruits), 7.5 cm to 22.5 cm (Pasture, horse gram, kidney bean, castor, pearl millet +horse gram), 22.5 to 45 cm (Monocropping of sunflower, pearl millet, red gram, pearl millet + red gram), 45 to 60 cm (*rabi* sorghum and safflower) and more than 60 cm (*rabi* sorghum, safflower, sunflower, gram, cotton or double cropping).

3. MATERIAL AND METHODS

To suggest crop planning for sustainable agriculture production in any particular district at tahasil level under *rainfed* condition, it is essential to study the behavior of rainfall at each tahasil level. The important aspects including onset of monsoon, distribution of monsoon and break in monsoon, probability of occurrence of rainfall on weekly basis, withdrawal of monsoon, starting, ending and duration of rainfall for Jalgaon district of Maharashtra state was studied on the above mentioned aspects so as to suggest the crops and cropping system for each tahasil considering different soil types. The methodologies adopted are described in following paragraphs under appropriate heads.

3.1 Collection of Data:

The historical data on daily rainfall at each tahasil level of Jalgaon district was collected from (1) All India Co-ordinated Research Project on Agrometeorology, ZARS, Solapur, (2) Department of Agriculture, Government of Maharashtra, (3) Statistics Department, Government of Maharashtra (4) India Meteorology Department, Pune and (5) Department of Agricultural Meteorology, College of Agriculture, Pune.

3.2 Processing of Data:

The daily data collected for each tahasil was summed up on meteorological weekly, monthly, seasonal and annual basis. For calculation of meteorological weekly basis, the year was partitioned as per meteorological calendar, starting from 1st January of each year and ending on 31st December of the same year. Calendar month wise data were processed and tabulated for further analysis.

The methodology, technique and procedure adopted for characterization of rainfall of Jalgaon district are discussed in this chapter. The procedures adopted are grouped under appropriate heads. The Weather Cock software developed by CRIDA, Hyderabad (Anonymous, 2013) was used for analysis of different weather parameters, *viz.*, annual, seasonal, monthly and weekly mean, standard deviation, coefficient of variation of rainfall and rainy days, arrival and withdrawal of monsoon and meteorological drought.

3.3 Collection of Data and Computerization

Daily rainfall data recorded at each tahasil headquarter was collected and used for Jalgaon district study. The daily rainfall data of 15 tahasils was available for last 56 years (1961-2016) and this data was used for further analysis and the result to that effect are presented and discussed in next chapter.

3.4 Statistical Analysis

The data collected for each tahasil of Jalgaon district was subjected to statistical analysis such as standard deviation, coefficient of variation, extreme lowest and highest, mean, arrival, departure and duration of rainy season, were estimated by forward and backward accumulation, from the computerized programme named Weather Cock developed by CRIDA, Hyderabad.

3.4.1 Annual Rainfall Variability (\bar{A}):

$$\text{Annual mean } (\bar{A}) = \frac{\sum_{i=1}^n A_i}{n} \quad \dots(3.1)$$

Standard deviation (mm):

$$\text{S.D.} = \sqrt{\frac{\sum (A_i - \bar{A})^2}{n-1}} \quad \dots(3.2)$$

Annual Coefficient of variation (C.V. %)

$$\text{C.V.} = \frac{\text{Standard deviation}}{\text{Mean}} \times 100 \quad \dots(3.3)$$

Where,

A_i = Annual rainfall of i^{th} year

n = Number of years

\bar{A} = Annual mean

3.4.2 Seasonal Rainfall Variability (\bar{S}):

$$\text{Seasonal mean rainfall } (\bar{S}) = \frac{\sum_{i=1}^n S_i}{n} \quad \dots(3.4)$$

Standard deviation (mm):

$$\text{S.D.} = \sqrt{\frac{\sum (S_i - \bar{S})^2}{n-1}} \quad \dots(3.5)$$

Seasonal Coefficient of variation (C.V. %)

$$C.V. = \frac{\text{Standard deviation}}{\text{Mean}} \times 100 \quad \dots\dots(3.6)$$

Where,

S_i = Seasonal rainfall of i^{th} year

C.V. = Coefficient of variation

S.D. = Standard deviation

n = Number of years

\bar{S} = Mean seasonal rainfall

3.4.3 Monthly Rainfall Variability (\bar{M}):

$$\text{Monthly mean rainfall } (\bar{M}) = \frac{\sum_{i=1}^n M_i}{n} \quad \dots\dots(3.7)$$

Standard deviation (mm):

$$S.D. = \sqrt{\frac{\sum (M_i - \bar{M})^2}{n-1}} \quad \dots\dots(3.8)$$

Monthly Coefficient of variation (C.V. %)

$$C.V. = \frac{\text{Standard deviation}}{\text{Mean}} \times 100 \quad \dots\dots(3.9)$$

Where,

M_i = Actual rainfall in the month / year

C.V. = Coefficient of variation

N = Number of months

S.D. = Standard deviation

\bar{M} = Mean monthly rainfall

3.4.4 Weekly Rainfall Variability (\bar{W}):

$$\text{Weekly mean rainfall } (\bar{W}) = \frac{\sum_{i=1}^n W_i}{n} \quad \dots\dots(3.10)$$

Standard deviation (mm) :

$$S.D. = \sqrt{\frac{\sum (W_i - \bar{W})^2}{n-1}} \quad \dots\dots(3.11)$$

Weekly Coefficient of variation (C.V. %):

$$\text{C.V.} = \frac{\text{Standard deviation}}{\text{Mean}} \times 100 \quad \dots\dots(3.12)$$

Where,

W_i = Actual rainfall in the week / year

n = Number of weeks

C.V. = Coefficient of variation

S.D. = Standard deviation

\bar{W} = Mean weekly rainfall (each week)

3.4.5 Surplus / Deficit of Annual Rainfall:

$$\text{Surplus / Deficit} = \frac{(\text{RF} - \text{Average RF})}{\text{Average RF}} \times 100$$

Where,

RF = Annual Rainfall

3.4.6 % Contribution of Seasonal Rainfall:

$$\% \text{ contribution} = \frac{\text{Dist. Mean of season}}{\text{Total Rainfall}} \times 100$$

3.4.7 % Contribution of Monthly Rainfall:

$$\% \text{ contribution} = \frac{\text{Monthly mean RF of tahasil}}{\text{Monthly average RF of tahasil}} \times 100$$

Where,

RF = Rainfall

3.4.8 % Contribution of Meteorological Drought:

$$\% \text{ drought contribution} = \frac{\text{No. of drought years}}{56 \text{ (years)}} \times 100$$

3.4.9 Onset and Withdrawl of Monsoon:

$$\text{LGP} = \text{Duration} \times 7$$

Where,

LGP = Length of growing period

3.5. Arrival and Departure:

For determining arrival and departure of monsoon, the frequency analysis of weekly rainfall was carried out on the basis of daily data of 56 years. For deciding arrival of monsoon weekly rainfall of 21 to 26 MW was considered. During this period the week which shows sudden rise in the rainfall is considered as arrival of monsoon.

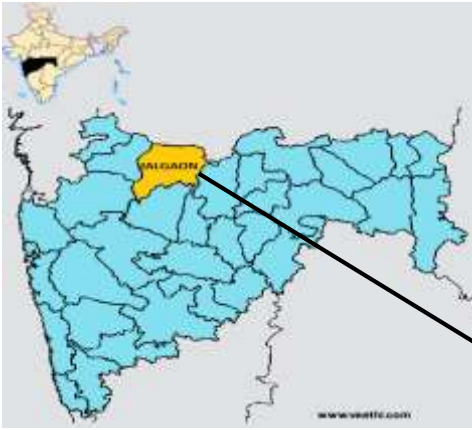
Similarly for deciding departure of monsoon, the rainfall of 38 to 48 MW was considered during this period, the sudden drop in the rainfall frequency value is considered as departure of monsoon.

3.6. Meteorological Drought:

On the basis of rainfall received for long term average value of rainfall over the area, the drought is classified as No drought year (rainfall less than 25 per cent than normal rainfall), Moderate drought year (rainfall less than 50 per cent than normal rainfall), Severe drought year (rainfall less than 75 per cent than normal rainfall).

3.7. Crop Suitability:

On the basis of analysis, study and considering the soil type prevailing in each tahasil, arrival and departure of monsoon and meteorological drought, the cropping system is suggested and also compared with present traditional cropping system.



Position of Jalgaon District in Maharashtra



Fig.1: Tahasilwise map of Jalgaon district

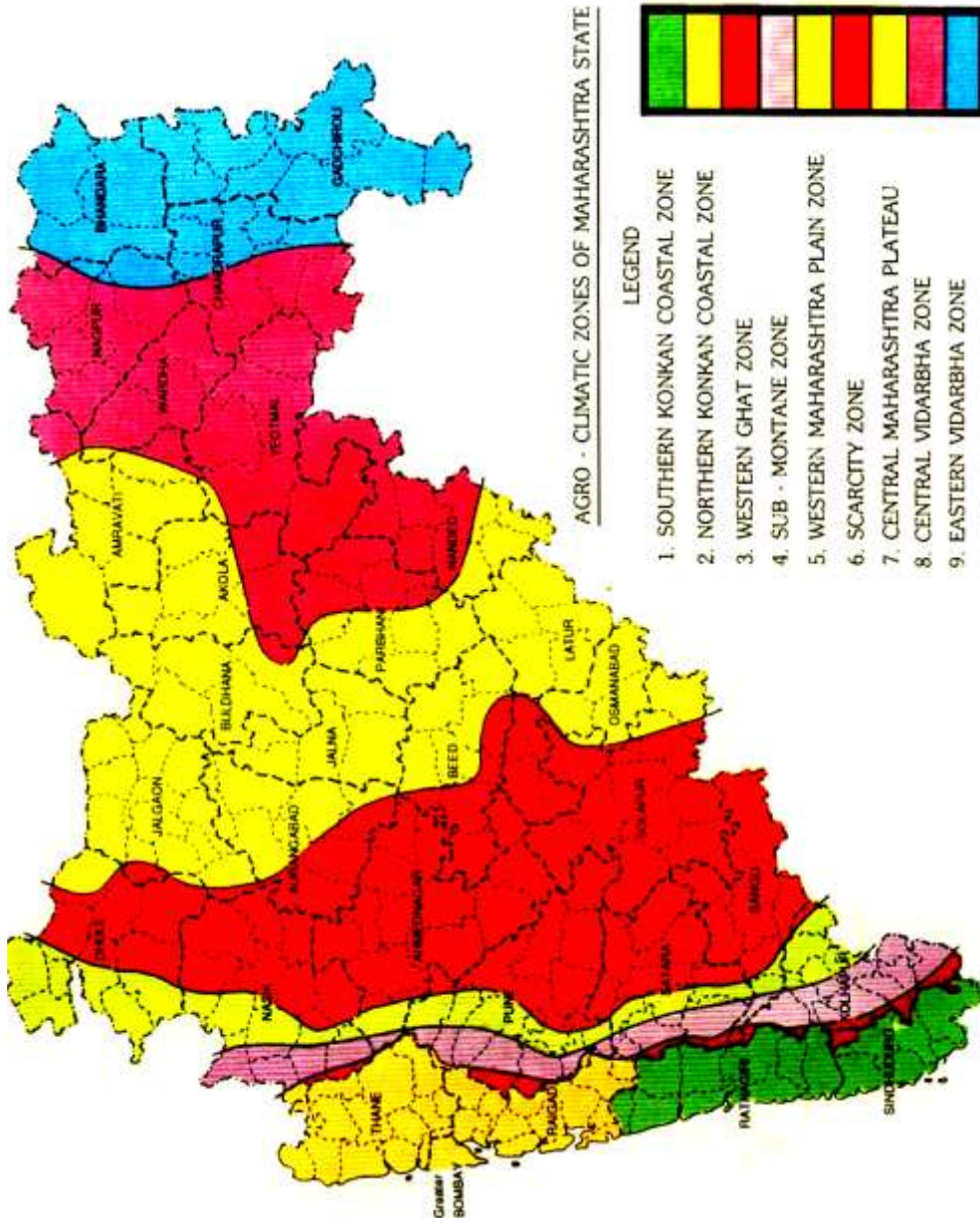


Fig.2: Agroclimatic zones of Maharashtra State

4. RESULTS AND DISCUSSION

The study on characterization of rainfall for each tahasil of Jalgaon district was conducted and results to that effect are presented in following paragraphs under appropriate heads.

4.1. Annual Rainfall:

The daily rainfall data recorded at each tahasil headquarter for the periods of fifty six years (1961-2016) were summed up for annual rainfall. The analysis of the annual rainfall and its variability at fifteen tahasil are presented in Table 1 and figures from 3.1 to 3.15.

The data indicated that average annual rainfall for fifty six years of Jalgaon district was 698.9 mm. It varied from 623.1 mm at Parola to 748.2 mm at Jamner. Further average annual rainfall recorded in various tahasils in their descending order was 748.2 mm at Jamner, 731.6 mm at Chalisgaon, 729.6 mm at Bhadagaon, 726.4 mm at Jalgaon, 716.4 mm at Pachora, 711.7 mm at Bodhwada, 711.5 mm at Chopada, 711.0 mm at Raver, 699.8 mm at Muktainagar, 685.0 mm at Erandol, 681.9 mm at Yawal, 731.6 mm at Chalisgaon, 667.2 mm at Dharangaon, 667.1 mm at Amalner and 623.1 mm at Parola.

The data revealed large variation in annual rainfall pattern with respect to all the tahasils. The highest annual rainfall was recorded as 1639.6 mm at Amalner during 1992 followed by 1458.4 mm at Yawal during 2006, 1457 mm at Chopada during 2006, 1441.6 mm at Parola during 2006, 1441.1 mm at Jalgaon during 2006, 1420.6 mm at Bhusawal during 2006, 1395 mm at Jamner during 1979, 1334.1 mm at Jalgaon during 2006, 1305 mm at Muktainagar during 2006, 1283.3 mm at Dhargaon during 2006, 1262 mm at Chalisgaon during 1989, 1250 mm at Raver during 1970, 1234.3 mm at Pachora during 1998, 1232.2 mm at Bhadagaon during 2006 and 1142.6 mm at Bhadagaon during 1975. The annual rainfall varied from western ghat to the scarcity zone of Jalgaon district.

The lowest rainfall of 373.4 mm was observed at Chopada during 1981, followed by Bhadagaon recorded 364.8 mm rainfall during 2012, Yawal recorded 360.4 mm rainfall during 1973, Muktainagar recorded 351 mm rainfall during 1968, Chalisgaon recorded 333.4 mm rainfall during 2000, Raver recorded 333 mm rainfall during 2000, Bodhwada recorded 327.4 mm rainfall during 1968, Amalner recorded 322.2 mm rainfall during 2000, Jalgaon recorded 320.2 mm rainfall during 2012, Parola recorded 316.4 mm rainfall during 1968, Jamner recorded 283.7 mm rainfall during 1972, Erandol recorded 262 mm rainfall during 1981, Pachora recorded 249.8 mm rainfall during 1985, Bhusawal recorded 172.7 mm rainfall during 1968 and Dhargaon recorded 43.3 mm rainfall during 1972. The lowest rainfall was mostly observed in scarcity zone of Jalgaon district.

The average highest rainfall surplus for the district was 44.08 per cent in the year 2006 and deficit was 67.09 per cent in the year 2012 for the period under study. This is because the year 2006 recorded the highest rainfall of 1250.0 mm and the year 2012 noted the lowest rainfall of 418.2 mm.

In the similar manner, surplus rainfall for all the 15 tahasils for fifty six years were noted in their descending order Amalner noted surplus rainfall of 972.5 mm with 245.77 per cent contribution in the year 1992, followed by Yawal of 766.5 mm with 210.8 per cent contribution in the year 2006. Chopada recorded 745.5 mm surplus rainfall with 204.8 per cent contribution in the year 2006. Jalgaon recorded 720.7 mm surplus with 199.6 per cent contribution in 2006. Parola recorded 818.5 mm with 231.3 per cent contribution in year 2006. Bhusawal recorded 745.5 mm with 210.4 per cent contribution in the year 2006. Jamner recorded 646.8 mm surplus rainfall with 186.4 per cent contribution in the year 1979. Erandol recorded 649.1 mm surplus with 194.8 per cent contribution in the year 2006. Muktainagar recorded 605.2 mm surplus rainfall with 86.5 per cent contribution in the year 2006. Dharangaon recorded 616.0 mm surplus rainfall with 92.3 per cent contribution in the year 2006. Chalisgaon recorded 530.4 mm surplus with 172.5 per cent contribution in 1989. Raver recorded 538.9 mm surplus with 175.8 per cent contribution in 1970. Pachora recorded 280.6 mm surplus with 172.3 per cent contribution in 1998. Bodhwada recorded 517.9 mm surplus with 77.3 per cent contribution in 2006 and Bhadagaon recorded 413.0 mm surplus with 156.6 per cent contribution in 1975. The surplus values showed the increased amount of rainfall over the normal rainfall.

The deficit rainfall was 52.48 per cent at Chopada during 1981, 50 per cent at Bhadagaon during 2012, 52.09 per cent at Yawal during 1973, 49.84 per cent at Muktainagar during 1968, 45.57 per cent at Chalisgaon during 2000, 46.83 per cent at Raver during 2000, 53.99 per cent at Bodhwada during 1968, 48.30 per cent at Amalner during 2000, 44.27 per cent at Jalgaon during 2012, 50.78 per cent at Parola during 1968, 37.92 per cent at Jamner during 1972, 72.86 per cent at Erandol during 1981, 34.87 at Pachora during 1985, 25.58 at Bhusawal during 1968 and 36.51 per cent at Dharangaon during 1972. The deficit values indicated that the annual rainfall was less than the normal rainfall.

Similar work was carried out by Gaikwad *et al.* (1996) at Solapur station, Dixit *et al.* (2005) in Konkan region, Mary *et al.* (2005) at Salur in Tamilnadu, Singh *et al.* (2008) at Sabour in Bihar, Gaikwad (2009) of Jalana district, Halikatti *et al.* (2010) at Dharawad in Karnataka, Birdar *et al.* (2010) at Bhalki tahasil in Karnataka, Dhanawade (2016) for Solapur district, Gangarde (2016) for Pune district, Patil (2017) for Kolhapur district and Shaikh *et al.* (2017 a) for Satara district.

Table 4.1: Tahasilwise annual rainfall (mm) variation in Jalgaon district (1961-2016)

Year	Amalner			Bhadagaon			Bhodwada		
	RF (mm)	RF = +/- (mm)	Sur/Def (%)	RF (mm)	RF = +/- (mm)	Sur/Def (%)	RF (mm)	RF = +/- (mm)	Sur/Def (%)
1961	495.1	-172.03	74.21	603.4	-126.18	82.71	914.1	202.39	28.43
1962	384.8	-282.33	57.68	526.5	-203.08	72.17	780.2	68.49	9.62
1963	663.3	-3.83	99.43	1101.5	371.92	150.98	641.3	-70.40	-9.89
1964	405.1	-262.03	60.72	1045.1	315.52	143.25	791.6	79.89	11.22
1965	605.8	-61.33	90.81	641.3	-88.28	87.90	579.0	-132.70	-18.64
1966	413.6	-253.53	62.00	812.1	82.52	111.31	588.4	-123.30	-17.32
1967	696.5	29.38	104.40	656.1	-73.48	89.93	403.8	-307.90	-43.26
1968	718.8	51.68	107.75	479.0	-250.58	65.65	327.4	-384.30	-53.99
1969	811.2	144.08	121.60	1130.0	400.42	154.88	818.7	106.99	15.03
1970	618.3	-48.83	92.68	1049.5	319.92	143.85	962.0	250.29	35.16
1971	509.0	-158.13	76.30	490.5	-239.08	67.23	357.7	-354.00	-49.74
1972	384.5	-282.63	57.64	366.6	-362.98	50.25	462.6	-249.10	-35.00
1973	782.9	115.78	117.35	1050.0	320.42	143.92	779.9	68.19	9.58
1974	849.0	181.88	127.26	480.6	-248.98	65.87	523.9	-187.80	-26.38
1975	1278.8	611.68	191.69	1142.6	413.02	156.61	784.8	73.09	10.27
1976	1512.5	845.38	226.72	896.0	166.42	122.81	535.0	-176.70	-24.82
1977	991.0	323.88	148.55	821.2	91.62	112.56	813.8	102.09	14.34
1978	613.5	-53.63	91.96	434.0	-295.58	59.49	810.0	98.29	13.81
1979	829.9	162.78	124.40	715.3	-14.28	98.04	1113.2	401.49	56.41
1980	548.6	-118.53	82.23	647.7	-81.88	88.78	981.9	270.19	37.96
1981	644.4	-22.73	96.59	637.7	-91.88	87.41	970.0	258.29	36.23
1982	503.0	-164.13	75.40	441.3	-288.28	60.49	615.5	-96.20	-13.51
1983	881.4	214.28	132.12	925.5	195.92	126.85	712.1	0.39	0.05
1984	751.3	84.18	112.62	494.1	-235.48	67.72	505.8	-205.90	-28.93
1985	555.8	-111.33	83.31	529.4	-200.18	72.56	592.5	-119.20	-16.74
1986	388.9	-278.23	58.29	521.6	-207.98	71.49	680.4	-31.30	-4.39
1987	689.1	21.98	103.29	824.8	95.22	113.05	677.0	-34.70	-4.87
1988	753.8	86.68	112.99	958.2	228.62	131.34	778.0	66.29	9.31
1989	587.0	-80.13	87.99	1042.9	313.32	142.95	866.0	154.29	21.67
1990	800.8	133.68	120.04	915.0	185.42	125.42	909.8	198.09	27.83
1991	513.6	-153.53	76.99	536.0	-193.58	73.47	589.5	-122.20	-17.17
1992	1639.6	972.48	245.77	738.0	8.42	101.15	759.3	47.59	6.68
1993	493.4	-173.73	73.96	749.0	19.42	102.66	825.7	113.99	16.0
1994	651.5	-15.63	97.66	683.0	-46.58	93.62	916.3	204.59	28.74
1995	390.4	-276.73	58.52	613.8	-115.78	84.13	732.4	20.69	2.90
1996	651.0	-16.13	97.58	833.6	104.02	114.26	601.8	-109.90	-15.44
1997	575.0	-92.13	86.19	966.0	236.42	132.41	757.0	45.29	6.36
1998	999.2	332.08	149.78	1083.3	353.72	148.48	1056.8	345.09	48.48
1999	628.0	-39.13	94.14	659.0	-70.58	90.33	590.6	-121.10	-17.01
2000	322.2	-344.93	48.30	472.0	-257.58	64.70	656.5	-55.20	-7.75
2001	598.3	-68.83	89.68	644.3	-85.28	88.31	715.6	3.89	0.54
2002	530.0	-137.13	79.45	605.1	-124.48	82.94	779.8	68.09	9.56
2003	847.0	179.88	126.96	1094.0	364.42	149.95	942.8	231.09	32.47
2004	717.0	49.88	107.48	628.0	-101.58	86.08	654.4	-57.30	-8.05
2005	398.2	-268.93	59.69	662.2	-67.38	90.76	571.4	-140.30	-19.71
2006	950.8	283.68	142.52	1033.8	304.22	141.70	1262.1	550.39	77.33
2007	713.7	46.58	106.98	531.6	-197.98	72.86	744.5	32.79	4.60
2008	506.0	-161.13	75.85	699.2	-30.38	95.84	460.1	-251.60	-35.35
2009	677.6	10.48	101.57	689.0	-40.58	94.44	657.0	-54.70	-7.68
2010	721.4	54.28	108.14	773.8	44.22	106.06	690.7	-21.00	-2.95
2011	478.8	-188.33	71.77	631.8	-97.78	86.60	529.2	-182.50	-25.64
2012	408.3	-258.83	61.20	364.8	-364.78	50.00	364.7	-347.00	-48.75
2013	769.5	102.38	115.35	928.3	198.72	127.24	835.5	123.79	17.39
2014	661.5	-5.63	99.16	661.0	-68.58	90.60	596.3	-115.40	-16.21
2015	391.1	-276.03	58.62	462.2	-267.38	63.35	538.5	-173.20	-24.33
2016	458.2	-208.93	68.68	734.0	4.42	100.61	750.6	38.89	5.46
Mean	667.1			729.6			711.7		
Max		1639.6			1142.6			1232.2	
Year		1992			1975			2006	
Min		322.2			364.8			327.4	
Year		2000			2012			1968	

Table 1 contd...

Table 4.1: Tahasilwise annual rainfall (mm) variation in Jalgaon district (1961-2016)

Year	Bhusawal			Chalisgaon			Chopada		
	RF (mm)	RF = +/- (mm)	Sur/Def (%)	RF (mm)	RF = +/- (mm)	Sur/Def (%)	RF (mm)	RF = +/- (mm)	Sur/Def (%)
1961	985.8	310.66	146.01	865.4	133.77	118.28	955.2	243.69	134.25
1962	757.9	82.76	112.26	869.2	137.57	118.80	472.5	-239.01	66.41
1963	555.9	-119.24	82.34	793.7	62.07	108.48	537.0	-174.51	75.47
1964	857.7	182.56	127.04	580.1	-151.53	79.29	641.9	-69.61	90.22
1965	625.1	-50.04	92.59	658.3	-73.33	89.98	463.0	-248.51	65.07
1966	411.3	-263.84	60.92	716.7	-14.93	97.96	433.5	-278.01	60.93
1967	432.2	-242.94	64.02	454.2	-277.43	62.08	455.0	-256.51	63.95
1968	172.7	-502.44	25.58	673.9	-57.73	92.11	913.1	201.59	128.33
1969	666.6	-8.54	98.74	1145	413.37	156.50	989.7	278.19	139.10
1970	840.8	165.66	124.54	1009	277.37	137.91	1169.6	458.09	164.38
1971	330.5	-344.64	48.95	478.2	-253.43	65.36	491.0	-220.51	69.01
1972	641.4	-33.74	95.00	504.3	-227.33	68.93	533.8	-177.71	75.02
1973	750.9	75.76	111.22	718.5	-13.13	98.21	759.7	48.19	106.77
1974	502.7	-172.44	74.46	678.8	-52.83	92.78	598.7	-112.81	84.14
1975	701.9	26.76	103.96	748.0	16.37	102.24	812.4	100.89	114.18
1976	574.0	-101.14	85.02	385.1	-346.53	52.64	1004.3	292.79	141.15
1977	757.9	82.76	112.26	641.3	-90.33	87.65	699.0	-12.51	98.24
1978	675.6	0.46	100.07	547.6	-184.03	74.85	581.0	-130.51	81.66
1979	831.4	156.26	123.15	644.4	-87.23	88.08	644.0	-67.51	90.51
1980	622.7	-52.44	92.23	678.2	-53.43	92.70	753.0	41.49	105.83
1981	761.8	86.66	112.84	744.0	12.37	101.69	373.4	-338.11	52.48
1982	631.7	-43.44	93.57	546.6	-185.03	74.71	440.0	-271.51	61.84
1983	591.7	-83.44	87.64	822.0	90.37	112.35	514.8	-196.71	72.35
1984	430.2	-244.94	63.72	759.0	27.37	103.74	426.0	-285.51	59.87
1985	627.5	-47.64	92.94	613.0	-118.63	83.79	640.0	-71.51	89.95
1986	807.0	131.86	119.53	713.4	-18.23	97.51	596.4	-115.11	83.82
1987	518.0	-157.14	76.73	1106.6	374.97	151.25	883.4	171.89	124.16
1988	794.6	119.46	117.69	1003.5	271.87	137.16	668.0	-43.51	93.88
1989	760.0	84.86	112.57	1262.0	530.37	172.49	625.0	-86.51	87.84
1990	766.6	91.46	113.55	893.0	161.37	122.06	871.0	159.49	122.42
1991	555.9	-119.24	82.34	693.0	-38.63	94.72	602.0	-109.51	84.61
1992	666.5	-8.64	98.72	690.0	-41.63	94.31	844.0	132.49	118.62
1993	878.3	203.16	130.09	891.0	159.37	121.78	841.0	129.49	118.20
1994	945.2	270.06	140.00	527.0	-204.63	72.03	925.0	213.49	130.01
1995	700.3	25.16	103.73	528.0	-203.63	72.17	662.0	-49.51	93.04
1996	607.3	-67.84	89.95	849.0	117.37	116.04	631.0	-80.51	88.68
1997	626.8	-48.34	92.84	1003.0	271.37	137.09	756.0	44.49	106.25
1998	971.2	296.06	143.85	1097.0	365.37	149.94	999.2	287.69	140.43
1999	486.2	-188.94	72.01	632.0	-99.63	86.38	430.0	-281.51	60.43
2000	701.9	26.76	103.96	333.4	-398.23	45.57	472.2	-239.31	66.37
2001	574.2	-100.94	85.05	666.0	-65.63	91.03	548.8	-162.71	77.13
2002	788.9	113.76	116.85	925.8	194.17	126.54	877.4	165.89	123.32
2003	898.5	223.36	133.08	1171.0	439.37	160.05	1105.2	393.69	155.33
2004	586.8	-88.34	86.92	506.0	-225.63	69.16	622.0	-89.51	87.42
2005	535.2	-139.94	79.27	379.4	-352.23	51.86	443.0	-268.51	62.26
2006	1420.6	745.46	210.42	1039.0	307.37	142.01	1457.0	745.49	204.78
2007	619.8	-55.34	91.80	624.6	-107.03	85.37	775.0	63.49	108.92
2008	335.0	-340.14	49.62	649.8	-81.83	88.82	555.2	-156.31	78.03
2009	683.7	8.56	101.27	747.0	15.37	102.10	863.8	152.29	121.40
2010	821.6	146.46	121.69	823.2	91.57	112.52	1025.0	313.49	144.06
2011	542.2	-132.94	80.31	695.8	-35.83	95.10	695.2	-16.31	97.71
2012	366.2	-308.94	54.24	388.0	-343.63	53.03	485.9	-225.61	68.29
2013	942.4	267.26	139.59	817.8	86.17	111.78	1186.9	475.39	166.81
2014	685.3	10.16	101.51	735.1	3.47	100.47	877.1	165.59	123.27
2015	641.1	-34.04	94.96	518.6	-213.03	70.88	499.9	-211.61	70.26
2016	842.5	167.36	124.79	787.9	56.27	107.69	719.4	7.89	101.11
Mean	675.13			731.63			711.5		
Max		1420.6			1262.0			1457.0	
Year		2006			1989			2006	
Min		172.7			333.4			373.4	
Year		1968			2000			1981	

Table 1 contd...

Table 4.1: Tahasilwise annual rainfall (mm) variation in Jalgaon district (1961-2016)

Year	Dharangaon			Erandol			Jalgaon		
	RF (mm)	RF = +/- (mm)	Sur/Def (%)	RF (mm)	RF = +/- (mm)	Sur/Def (%)	RF (mm)	RF = +/- (mm)	Sur/Def (%)
1961	705.6	38.32	5.74	968.6	283.59	141.40	883.5	160.13	122.14
1962	450.2	-217.07	-32.53	482.4	-202.61	70.42	755.2	31.83	104.40
1963	596.9	-70.37	-10.54	679.9	-5.11	99.25	663.4	-59.97	91.71
1964	526.5	-140.77	-21.09	608.6	-76.41	88.85	847.1	123.73	117.10
1965	496.3	-170.97	-25.62	530.2	-154.81	77.40	569.3	-154.07	78.70
1966	447.9	-219.37	-32.87	533.0	-152.01	77.81	557.9	-165.47	77.13
1967	562.2	-105.07	-15.74	650.0	-35.01	94.89	825.6	102.23	114.13
1968	649.5	-17.77	-2.66	916.5	231.49	133.79	469.3	-254.07	64.88
1969	776.9	109.62	16.42	572.0	-113.01	83.50	901.6	178.23	124.64
1970	815.7	148.42	22.24	682.4	-2.61	99.62	962.8	239.43	133.10
1971	477.8	-189.47	-28.39	390.2	-294.81	56.96	650.0	-73.37	89.86
1972	423.6	-243.67	-36.51	413.8	-271.21	60.41	477.4	-245.97	66.00
1973	671.1	3.82	0.57	728.2	43.19	106.30	822.8	99.43	113.75
1974	652.5	-14.77	-2.21	632.1	-52.91	92.28	702.1	-21.27	97.06
1975	937.1	269.82	40.43	747.3	62.29	109.09	851.0	127.63	117.64
1976	1058.0	390.72	58.55	645.4	-39.61	94.22	709.2	-14.17	98.04
1977	693.0	25.72	3.85	623.4	-61.61	91.01	820.2	96.83	113.39
1978	511.8	-155.47	-23.29	623.5	-61.51	91.02	793.6	70.23	109.71
1979	663.0	-4.27	-0.64	680.0	-5.01	99.27	792.8	69.43	109.60
1980	579.9	-87.37	-13.09	375.9	-309.11	54.88	666.2	-57.17	92.10
1981	558.9	-108.37	-16.24	499.1	-185.91	72.86	801.0	77.63	110.73
1982	472.9	-194.37	-29.12	267.0	-418.01	38.98	648.8	-74.57	89.69
1983	828.7	161.42	24.19	940.5	255.49	137.30	860.2	136.83	118.92
1984	623.1	-44.17	-6.61	530.5	-154.51	77.44	479.6	-243.77	66.30
1985	589.1	-78.17	-11.71	409.5	-275.51	59.78	459.4	-263.97	63.51
1986	447.7	-219.57	-32.90	533.0	-152.01	77.81	422.6	-300.77	58.42
1987	749.3	82.02	12.29	650.0	-35.01	94.89	714.4	-8.97	98.76
1988	644.3	-22.97	-3.44	916.5	231.49	133.79	654.5	-68.87	90.48
1989	560.8	-106.47	-15.95	572.0	-113.01	83.50	1915.6	1192.23	264.82
1990	738.9	71.62	10.73	1141.3	456.29	166.61	995.7	272.33	137.65
1991	527.2	-140.07	-20.99	749.7	64.69	109.44	505.2	-218.17	69.84
1992	1094.2	426.92	63.98	838.0	152.99	122.33	557.9	-165.47	77.13
1993	655.3	-11.97	-1.79	682.0	-3.01	99.56	384.9	-338.47	53.21
1994	777.4	110.12	16.50	659.0	-26.01	96.20	559.6	-163.77	77.36
1995	539.1	-128.17	-19.20	522.2	-162.81	76.23	599.5	-123.87	82.88
1996	628.4	-38.87	-5.82	535.0	-150.01	78.10	577.1	-146.27	79.78
1997	675.8	8.52	1.27	794.0	108.99	115.91	410.2	-313.17	56.71
1998	1030.6	363.32	54.44	1037.8	352.79	151.50	792.0	68.63	109.49
1999	620.3	-46.97	-7.03	717.1	32.09	104.68	606.6	-116.77	83.86
2000	436.1	-231.17	-34.64	505.2	-179.81	73.75	732.0	8.63	101.19
2001	657.0	-10.27	-1.53	701.0	15.99	102.33	772.0	48.63	106.72
2002	699.5	32.22	4.82	825.4	140.39	120.49	939.7	216.33	129.91
2003	988.2	320.92	48.09	1003.0	317.99	146.42	1216.2	492.83	168.13
2004	649.9	-17.37	-2.60	589.0	-96.01	85.98	531.5	-191.87	73.48
2005	467.5	-199.77	-29.93	509.0	-176.01	74.31	506.5	-216.87	70.02
2006	1283.3	616.02	92.32	1334.1	649.09	194.76	1444.1	720.73	199.64
2007	748.6	81.32	12.18	720.0	34.99	105.11	752.7	29.33	104.05
2008	544.9	-122.37	-18.33	663.0	-22.01	96.79	422.7	-300.67	58.43
2009	740.6	73.32	10.98	865.0	179.99	126.28	754.1	30.73	104.25
2010	854.4	187.12	28.04	864.5	179.49	126.20	752.4	29.03	104.01
2011	579.4	-87.87	-13.16	686.0	0.99	100.14	735.7	12.33	101.70
2012	482.7	-184.57	-27.66	488.0	-197.01	71.24	320.2	-403.17	44.27
2013	1004.8	337.52	50.58	932.2	247.19	136.09	987.5	264.13	136.51
2014	718.9	51.62	7.73	904.4	219.39	132.03	805.6	82.23	111.37
2015	442.5	-224.77	-33.68	524.8	-160.21	76.61	423.0	-300.37	58.48
2016	611.5	-55.77	-8.35	768.4	83.39	112.17	747.0	23.63	103.27
Mean	667.27			685.01			723.3696		
Max		1283.3			1334.1			1444.1	
Year		2006			2006			2006	
Min		43.2			267.0			320.2	
Year		1972			1981			2012	

Table 1 contd...

Table 4.1: Tahasilwise annual rainfall (mm) variation in Jalgaon district (1961-2016)

Year	Jamner			Muktainagar			Pachora		
	RF (mm)	RF = +/- (mm)	Sur/Def (%)	RF (mm)	RF = +/- (mm)	Sur/Def (%)	RF (mm)	RF = +/- (mm)	Sur/Def (%)
1961	842.4	94.17	112.59	973.0	273.17	39.03	657.2	-59.18	91.74
1962	802.4	54.17	107.24	734.0	34.17	4.883	840.0	123.62	117.26
1963	726.6	-21.63	97.11	667.0	-32.82	-4.68	1029.4	313.02	143.69
1964	725.5	-22.73	96.96	883.0	183.17	26.17	826.4	110.02	115.36
1965	532.9	-215.33	71.22	572.0	-127.82	-18.26	714.7	-1.68	99.77
1966	765.4	17.17	102.29	486.0	-213.82	-30.55	1083.7	367.32	151.27
1967	375.4	-372.83	50.17	566.0	-133.82	-19.12	699.6	-16.78	97.66
1968	482.1	-266.13	64.43	351.0	-348.82	-49.84	7860.0	69.62	109.72
1969	970.8	222.57	129.75	705.0	5.17	0.73	1080.9	364.52	150.88
1970	1083.1	334.87	144.75	1020.0	320.17	45.75	1080.5	364.12	150.83
1971	384.9	-363.33	51.44	380.0	-319.82	-45.70	529.2	-187.18	73.87
1972	283.7	-464.53	37.92	498.0	-201.82	-28.83	379.3	-337.08	52.95
1973	808.9	60.67	108.11	847.0	147.17	21.03	1135.8	419.42	158.55
1974	545.1	-203.13	72.85	576.0	-123.82	-17.69	353.7	-362.68	49.37
1975	867.6	119.37	115.95	779.0	79.17	11.31	1057.5	341.12	147.62
1976	496.0	-252.23	66.29	686.0	-13.82	-1.97	655.5	-60.88	91.50
1977	869.6	121.37	116.22	760.0	60.17	8.59	945.0	228.62	131.91
1978	944.4	196.17	126.22	763.0	63.17	9.02	586.0	-130.38	81.80
1979	1395.0	646.77	186.44	945.0	245.17	35.03	730.0	13.62	101.90
1980	1341.0	592.77	179.22	741.0	41.17	5.88	646.6	-69.78	90.26
1981	1178.2	429.97	157.46	897.0	197.17	28.17	635.5	-80.88	88.71
1982	599.3	-148.93	80.10	604.0	-95.82	-13.69	499.0	-217.38	69.66
1983	832.4	84.17	111.25	739.0	39.17	5.59	927.0	210.62	129.40
1984	581.3	-166.93	77.69	456.0	-243.82	-34.84	380.7	-335.68	53.14
1985	557.5	-190.73	74.51	580.0	-119.82	-17.12	249.8	-466.58	34.87
1986	553.7	-194.53	74.00	694.0	-5.82	-0.83	508.7	-207.68	71.01
1987	836.0	87.77	111.73	635.0	-64.82	-9.26	830.3	113.92	115.90
1988	761.4	13.17	101.76	803.0	103.17	14.74	1022.3	305.92	142.70
1989	972.0	223.77	129.91	844.0	144.17	20.60	863.6	147.22	120.55
1990	1053.0	304.77	140.73	726.0	26.17	3.74	839.0	122.62	117.12
1991	623.0	-125.23	83.26	543.0	-156.82	-22.40	480.7	-235.68	67.10
1992	852.0	103.77	113.87	675.0	-24.82	-3.54	621.0	-95.38	86.69
1993	773.1	24.87	103.32	919.0	219.17	31.31	741.6	25.22	103.52
1994	887.4	139.17	118.60	851.0	151.17	21.60	402.2	-314.18	56.14
1995	764.5	16.27	102.17	719.0	19.17	2.74	541.0	-175.38	75.52
1996	596.2	-152.03	79.68	609.0	-90.82	-12.97	879.0	162.62	122.70
1997	887.2	138.97	118.57	753.0	53.17	7.59	799.5	83.12	111.60
1998	1142.3	394.07	152.67	955.0	255.17	36.46	1234.3	517.92	172.30
1999	695.0	-53.23	92.89	601.0	-98.82	-14.12	553.0	-163.38	77.19
2000	611.0	-137.23	81.66	566.0	-133.82	-19.12	381.0	-335.38	53.18
2001	857.0	108.77	114.54	600.0	-99.82	-14.26	588.0	-128.38	82.08
2002	770.7	22.47	103.00	800.0	100.17	14.31	587.2	-129.18	81.97
2003	987.0	238.77	131.91	889.0	189.17	27.03	1016.6	300.22	141.91
2004	722.0	-26.23	96.49	657.0	-42.82	-6.11	566.0	-150.38	79.01
2005	607.6	-140.63	81.20	518.0	-181.82	-25.98	588.9	-127.48	82.20
2006	1103.6	355.37	147.49	1305.0	605.17	86.47	984.0	267.62	137.36
2007	869.2	120.97	116.17	707.0	7.17	1.02	582.4	-133.98	81.30
2008	585.2	-163.03	78.21	419.0	-280.82	-40.12	587.1	-129.28	81.95
2009	630.2	-118.03	84.22	654.0	-45.82	-6.54	716.6	0.22	100.03
2010	559.7	-188.53	74.80	802.0	102.17	14.60	886.6	170.22	123.76
2011	516.1	-232.13	68.98	527.0	-172.82	-24.69	657.2	-59.18	91.74
2012	363.2	-385.03	48.54	381.0	-318.82	-45.55	388.4	-327.98	54.22
2013	728.5	-19.73	97.36	850.0	150.17	21.45	871.4	155.02	121.64
2014	507.2	-241.03	67.79	639.0	-60.82	-8.690	699.0	-17.38	97.57
2015	435.9	-312.33	58.26	585.0	-114.82	-16.40	484.5	-231.88	67.63
2016	658.7	-89.53	88.03	756.0	56.17	8.02	707.3	-9.08	98.73
Mean	748.23			699.8			716.3		
Max		1395.0			1305.0			1234.3	
Year		1979			2006			1998	
Min		283.7			351.0			249.8	
Year		1972			1968			1985	

Table 1 contd...

Table 4.1: Tahasilwise annual rainfall (mm) variation in Jalgaon district (1961-2016)

Year	Parola			Raver			Yawal		
	RF (mm)	RF = +/- (mm)	Sur/Def (%)	RF (mm)	RF = +/- (mm)	Sur/Def (%)	RF (mm)	RF = +/- (mm)	Sur/Def (%)
1961	666.5	43.38	106.96	1025.0	313.94	144.15	692.9	0.98	100.14
1962	492.2	-130.92	78.99	679.3	-31.76	95.53	616.0	-75.92	89.03
1963	591.7	-31.42	94.96	790.0	78.94	111.10	665.2	-26.72	96.14
1964	532.8	-90.32	85.51	999.5	288.44	140.56	827.2	135.28	119.55
1965	418.9	-204.22	67.23	518.2	-192.86	72.88	440.9	-251.02	63.72
1966	495.2	-127.92	79.47	460.0	-251.06	64.69	613.9	-78.02	88.72
1967	532.6	-90.52	85.47	852.9	141.84	119.95	447.7	-244.22	64.70
1968	316.4	-306.72	50.78	561.8	-149.26	79.01	748.4	56.48	108.16
1969	528.7	-94.42	84.85	617.5	-93.56	86.84	768.0	76.08	111.00
1970	659.5	36.38	105.84	1250.0	538.94	175.79	1005.2	313.28	145.28
1971	434.0	-189.12	69.65	452.3	-258.76	63.61	420.4	-271.52	60.76
1972	353.0	-270.12	56.65	402.0	-309.06	56.54	393.0	-298.92	56.80
1973	470.5	-152.62	75.51	1012.0	300.94	142.32	360.4	-331.52	52.09
1974	509.6	-113.52	81.78	696.7	-14.36	97.98	519.1	-172.82	75.02
1975	719.9	96.78	115.53	836.0	124.94	117.57	536.1	-155.82	77.48
1976	657.6	34.48	105.53	947.0	235.94	133.18	505.6	-186.32	73.07
1977	390.2	-232.92	62.62	707.0	-4.06	99.43	487.3	-204.62	70.43
1978	340.3	-282.82	54.61	799.4	88.34	112.42	505.8	-186.12	73.10
1979	515.8	-107.32	82.78	892.5	181.44	125.52	792.2	100.28	114.49
1980	438.6	-184.52	70.39	622.3	-88.76	87.52	362.8	-329.12	52.43
1981	657.7	34.58	105.55	960.4	249.34	135.07	1056.9	364.98	152.75
1982	475.2	-147.92	76.26	559.1	-151.96	78.63	700.9	8.98	101.30
1983	1089.5	466.38	174.85	916.1	205.04	128.84	512.0	-179.92	74.00
1984	693.1	69.98	111.23	424.0	-287.06	59.63	478.5	-213.42	69.16
1985	571.4	-51.72	91.70	510.0	-201.06	71.72	509.7	-182.22	73.66
1986	358.6	-264.52	57.55	591.0	-120.06	83.12	573.8	-118.12	82.93
1987	676.8	53.68	108.61	706.0	-5.06	99.29	795.1	103.18	114.91
1988	512.1	-111.02	82.18	830.0	118.94	116.73	892.6	200.68	129.00
1989	470.6	-152.52	75.52	899.1	188.04	126.44	921.5	229.58	133.18
1990	543.2	-79.92	87.17	483.8	-227.26	68.04	917.0	225.08	132.53
1991	466.5	-156.62	74.87	483.0	-228.06	67.93	645.0	-46.92	93.22
1992	798.8	175.68	128.19	597.0	-114.06	83.96	641.0	-50.92	92.64
1993	629.9	6.78	101.09	1042.0	330.94	146.54	816.0	124.08	117.93
1994	755.3	132.18	121.21	704.0	-7.06	99.01	754.0	62.08	108.97
1995	564.5	-58.62	90.59	715.0	3.94	100.55	736.3	44.38	106.41
1996	603.1	-20.02	96.79	614.0	-97.06	86.35	746.0	54.08	107.82
1997	695.6	72.48	111.63	875.0	163.94	123.06	630.0	-61.92	91.05
1998	1092.8	469.68	175.38	831.1	120.04	116.88	1051.0	359.08	151.90
1999	802.0	178.88	128.71	726.0	14.94	102.10	369.0	-322.92	53.33
2000	513.0	-110.12	82.33	333.0	-378.06	46.83	602.0	-89.92	87.00
2001	824.6	201.48	132.33	508.6	-202.46	71.53	557.0	-134.92	80.50
2002	691.4	68.28	110.96	826.2	115.14	116.19	744.8	52.88	107.64
2003	1012.3	389.18	162.46	806.3	95.24	113.39	998.0	306.08	144.24
2004	611.0	-12.12	98.05	728.0	16.94	102.38	694.0	2.08	100.30
2005	562.1	-61.02	90.21	449.0	-262.06	63.15	573.0	-118.92	82.81
2006	1441.6	818.48	231.35	1232.0	520.94	173.26	1458.4	766.48	210.78
2007	756.3	133.18	121.37	769.3	58.24	108.19	814.5	122.58	117.72
2008	573.0	-50.12	91.96	453.3	-257.76	63.75	458.2	-233.72	66.22
2009	680.1	56.98	109.14	614.0	-97.06	86.35	670.0	-21.92	96.83
2010	817.0	193.88	131.11	876.2	165.14	123.22	1057.2	365.28	152.79
2011	563.9	-59.22	90.50	510.0	-201.06	71.72	626.6	-65.32	90.56
2012	555.4	-67.72	89.13	426.8	-284.26	60.02	490.0	-201.92	70.82
2013	1059.0	435.88	169.95	784.5	73.44	110.33	1016.1	324.18	146.85
2014	619.0	-4.12	99.34	639.5	-71.56	89.94	834.4	142.48	120.59
2015	436.4	-186.72	70.03	593.3	-117.76	83.44	476.4	-215.52	68.85
2016	658	34.88	105.60	681.4	-29.66	95.83	662.4	-29.52	95.73
Mean	623.12			711.06			681.9		
Max		1441.6			1250.0			1458.4	
Year		2006			1970			2006	
Min		316.4			333.0			360.4	
Year		1968			2000			1973	

Table 1 contd....

Table 4.1: Tahasilwise annual rainfall (mm) variation in Jalgaon district (1961-2016)

District Average			
RF (mm)	RF (mm)	RF = +/- (mm)	Sur/Def (%)
1961	815.5	116.7	14.31
1962	642.8	-56.00	-8.71
1963	713.5	14.66	2.05
1964	739.8	41.01	5.54
1965	557.7	-141.13	-25.30
1966	587.9	-110.95	-18.87
1967	573.9	-124.87	-21.75
1968	571.0	-127.79	-22.37
1969	832.1	133.31	16.02
1970	947.2	248.36	26.22
1971	451.7	-247.14	-54.71
1972	434.4	-264.39	-60.85
1973	779.9	81.04	10.39
1974	588.0	-110.8	-18.84
1975	853.3	154.47	18.10
1976	751.1	52.28	6.96
1977	734.6	35.80	4.87
1978	635.3	-63.55	-10.00
1979	812.3	113.44	13.96
1980	667.0	-31.76	-4.76
1981	758.4	59.54	7.85
1982	533.6	-165.23	-30.96
1983	806.1	107.33	13.31
1984	534.2	-164.64	-30.82
1985	532.9	-165.88	-31.12
1986	559.3	-139.47	-24.93
1987	752.7	53.92	7.16
1988	799.5	100.66	12.59
1989	877.4	178.61	20.35
1990	839.6	140.74	16.76
1991	567.5	-131.30	-23.13
1992	800.8	101.96	12.73
1993	754.8	55.95	7.41
1994	733.1	34.33	4.68
1995	621.8	-76.99	-12.38
1996	664.1	-34.75	-5.23
1997	746.9	48.08	6.43
1998	1024.9	326.04	31.81
1999	607.7	-91.13	-14.99
2000	509.1	-189.69	-37.25
2001	654.1	-44.69	-6.83
2002	759.4	60.60	7.97
2003	998.3	299.48	29.99
2004	630.8	-68.01	-10.78
2005	518.0	-180.79	-34.89
2006	1249.9	551.10	44.08
2007	715.2	16.42	2.29
2008	527.4	-171.41	-32.49
2009	709.5	10.65	1.50
2010	821.7	122.85	14.95
2011	598.3	-100.53	-16.80
2012	418.2	-280.61	-67.09
2013	914.2	215.43	23.56
2014	705.5	6.69	0.94
2015	496.8	-201.97	-40.64
2016	702.8	4.02	0.57
Mean	698.8		
Max		1249.96	
Year		2006	
Min		418.24	
Year		2012	

4.2. Annual Rainy Days:

The number of rainy days is a good indicator for distribution of annual rainfall. It will be helpful for region specific crop planning. Daily rainfall received as 2.5 mm or more than 2.5 mm is called rainy day. The analysis of the annual rainy days and its variability at the fifteen places based on 56 years of data are presented in Table 2.

The average annual rainfall of Jalgaon district was 698.9 mm which was received in 43 rainy days with the highest of 61 rainy days during 2016 and the lowest of 25 rainy days during 2000.

There was wide variation among the tahasils with respect to number of rainy days during the period under study. The average number of rainy days ranged from 53 days in Dharangaon to 38 days in Amalner. While, the mean rainy days recorded in different tahasils of Jalgaon were 53 rainy days in Dhargaon, 51 rainy days in Muktainagar, 48 rainy days in Bodhwada and 43 rainy days in Jalgaon, Parola, 42 rainy days Chalisgaon, Chopada and Pachora, 41 days in Bhadagaon, Jamner, Raver and Yawal, 40 rainy days in Erandol and 39 rainy days Bhusawal and 38 rainy days in Amalner.

With respect to the highest number of rainy days Muktainagar recorded 73 rainy days in 1962 followed by 72 rainy days at Dharangaon in the year 1983, 70 rainy days at Parola in the year 2013, 69 rainy days at Pachora in the year 2010, 67 rainy days at Bodhwada in the year 2013, 67 rainy days at Chopada in the year 2010, 64 rainy days at Bhadagaon in the year 2013, 62 rainy days at Chalisgaon in the year 1983 and Jamner in the year 2013, 61 rainy days at Yawal in the year 2010, 60 rainy days at Bhusawal in the year 1998 and Erandol in the year 2013 and Jalgaon in the year 2010, 59 rainy days at Amalner in the year 2010 and 56 rainy days Raver in the year 1969.

The least number of rainy days in different tahasils were observed and there was wide variation amongst the tahasilwise rainy days. Bodhwada recorded 29 rainy days in the year 1984, followed by Muktainagar recorded 28 rainy days during the year 1984, 27 rainy days at Yawal in the year 2015, 26 rainy days at Dharangaon and Jalgaon in the year 2000, 24 rainy days were recorded at Erandol in the year 2002 and Jamner in the year 1972 and 23 rainy days Parola in the year 2000, 22 rainy days at Bhadagaon in the year 2002, 21 rainy days Amalner in the year 2000, 20 rainy days at Chalisgaon, Chopada in the year 2000 and at Raver in the year 1972, 18 rainy days at Bhusawal in the year 1968 and 13 rainy days at Pachora in the year 2000.

All the above observations show that the total number of rainy days varied from agroclimatic zone from Ghat zone to scarcity zone. Similar work was carried out by Gaikwad *et al* (1996) and Dixit *et al* (2005) at Solapur and Konkan region respectively. Shaikh *et al*. (2018 a) also reported similar finding on Satara district of Maharashtra State\

Table 4.2: Tahasilwise annual rainy days (Numbers) variation in Jalgaon district (1961-2016)

Year	Amalner	Bhadagaon	Bhodwada	Bhusawal	Chalisgaon	Chopada	Dharangaon	Erandol
1961	29	41	62	58	48	61	56	41
1962	30	48	50	40	43	35	53	43
1963	37	54	53	34	46	36	65	31
1964	36	51	60	49	43	41	53	43
1965	44	36	48	38	36	30	56	39
1966	21	44	44	30	36	54	52	31
1967	38	37	52	34	24	48	66	32
1968	31	25	36	18	32	35	42	46
1969	41	39	53	44	42	49	61	37
1970	40	54	54	43	48	46	63	41
1971	31	22	41	38	25	35	49	32
1972	24	28	42	27	28	27	36	29
1973	43	47	58	49	45	50	58	41
1974	32	31	46	36	45	35	45	38
1975	42	49	55	52	42	51	68	45
1976	53	47	48	37	45	46	68	45
1977	44	47	58	36	53	40	54	43
1978	42	34	40	31	56	38	50	40
1979	43	39	56	40	49	38	61	37
1980	33	33	51	37	51	41	47	31
1981	44	31	58	51	50	47	64	39
1982	35	28	43	28	31	31	50	27
1983	47	49	57	45	62	45	72	48
1984	33	30	29	24	34	26	52	25
1985	29	37	32	29	29	29	47	27
1986	32	32	43	35	28	40	42	31
1987	44	42	46	38	45	36	57	32
1988	48	53	59	49	50	41	63	46
1989	34	42	52	39	44	39	48	37
1990	49	51	64	44	50	47	61	48
1991	30	32	39	34	33	34	43	35
1992	38	35	48	37	37	49	62	47
1993	41	47	53	46	57	50	68	42
1994	53	41	63	53	34	62	61	48
1995	32	40	45	37	31	43	56	36
1996	40	45	44	34	47	41	54	40
1997	43	55	50	38	55	47	64	43
1998	52	51	63	60	47	52	59	55
1999	36	39	52	41	38	32	49	53
2000	21	23	36	32	20	20	26	26
2001	34	38	41	34	43	38	45	37
2002	24	22	32	34	29	29	36	24
2003	53	55	55	50	57	44	61	53
2004	41	48	44	37	41	39	57	44
2005	31	45	47	41	42	38	44	35
2006	50	43	48	53	50	51	57	48
2007	43	39	52	41	49	45	50	50
2008	36	36	40	33	39	49	48	46
2009	37	36	38	35	44	42	44	39
2010	59	52	57	51	61	67	68	58
2011	36	47	48	44	46	37	39	45
2012	29	42	35	34	34	34	35	37
2013	54	64	67	56	58	57	67	60
2014	40	45	36	27	36	37	45	45
2015	27	32	34	29	33	28	30	39
2016	39	49	47	47	47	43	48	52
Mean	38	41	48	39	42	42	53	40
Highest	59	64	67	60	62	67	72	60
Year	2010	2013	2013	1998	1983	2010	1983	2013
Lowest	21	22	29	18	20	20	26	24
Year	2000	2002	1984	1968	2000	2000	2000	2002

Table 2 Cont...

Table 4.2: Tahasilwise annual rainy days (Numbers) variation in Jalgaon district (1961-2016)

Year	Jalgaon	Jamner	Muktainagar	Pachora	Parola	Raver	Yawal	District Average
1961	55	51	70	41	37	51	50	50
1962	44	42	73	52	48	55	41	46
1963	43	47	58	52	52	43	36	46
1964	51	45	69	41	47	50	47	48
1965	35	33	53	32	37	31	30	39
1966	38	37	54	40	41	34	28	39
1967	47	45	60	39	41	54	28	43
1968	36	30	43	38	37	50	32	35
1969	52	42	59	46	45	56	44	47
1970	52	46	55	47	55	49	51	50
1971	31	24	44	34	40	33	41	35
1972	39	24	32	27	31	20	36	30
1973	48	49	57	49	43	46	37	48
1974	45	40	48	47	42	39	45	41
1975	53	39	64	46	51	49	44	50
1976	47	41	54	36	44	51	33	46
1977	40	48	55	47	38	42	46	46
1978	53	33	45	41	36	41	43	42
1979	47	41	61	41	41	44	53	46
1980	40	43	55	40	38	41	34	41
1981	45	46	70	41	50	53	53	49
1982	35	41	42	30	39	31	31	35
1983	50	50	62	48	63	41	47	52
1984	30	32	28	26	39	24	28	31
1985	29	26	40	31	35	33	35	33
1986	26	33	43	22	30	26	35	33
1987	45	41	44	48	43	38	37	42
1988	41	47	62	53	42	44	38	49
1989	52	49	58	44	36	49	43	44
1990	52	60	54	46	42	34	45	50
1991	33	31	39	34	33	22	40	34
1992	51	39	47	45	49	31	40	44
1993	37	49	65	51	46	51	51	50
1994	36	54	55	31	45	45	49	49
1995	40	37	50	29	35	37	38	39
1996	42	40	42	48	48	41	47	44
1997	34	49	52	58	53	45	42	49
1998	50	52	67	57	54	47	58	55
1999	38	46	53	40	44	39	33	42
2000	26	27	36	13	23	24	23	25
2001	31	37	35	42	36	29	28	37
2002	38	26	37	25	29	31	35	30
2003	49	44	58	57	54	36	47	52
2004	43	35	50	42	44	39	43	43
2005	40	36	48	38	39	35	43	40
2006	49	39	52	43	50	43	50	48
2007	56	42	53	47	40	45	38	46
2008	38	38	43	38	38	34	40	40
2009	37	40	41	43	39	37	35	39
2010	60	49	60	69	59	54	61	59
2011	55	47	48	45	40	42	45	44
2012	31	41	35	41	39	33	33	36
2013	57	62	61	60	70	55	60	61
2014	43	37	35	43	39	36	43	39
2015	29	31	35	29	30	35	27	31
2016	45	46	53	50	48	53	52	48
Mean	43	41	51	42	43	41	41	43
Highest Year	60	62	73	69	70	56	61	61
Lowest Year	26	24	28	13	23	20	27	25
Year	2000	1972	1984	2000	2000	1972	2015	2000

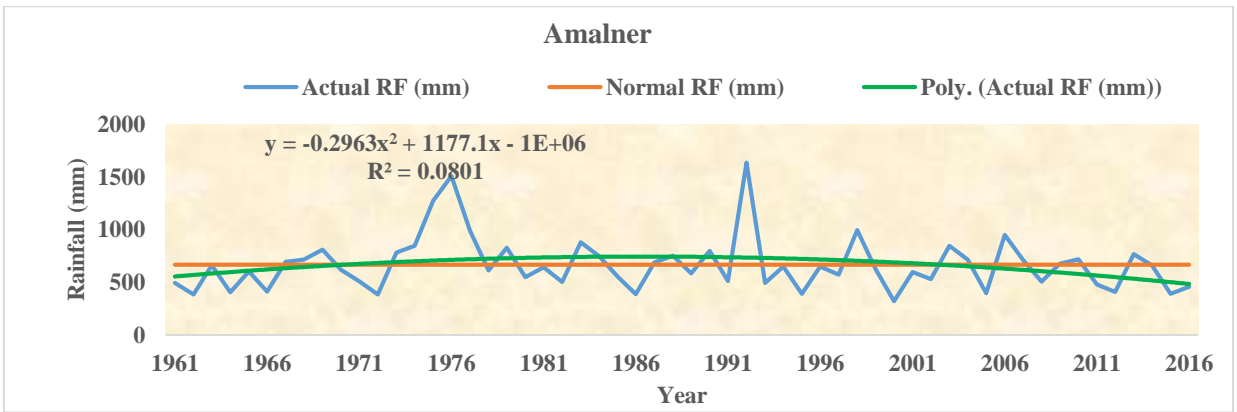


Fig 3: Annual rainfall of Amalner tahasil (1961-2016)

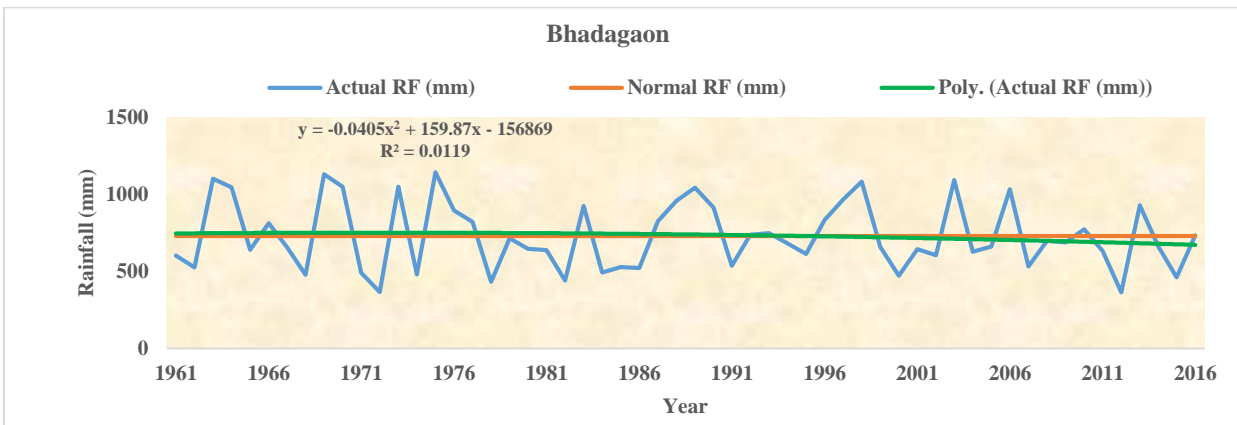


Fig 4: Annual rainfall of Bhadagaon tahasil (1961-2016)

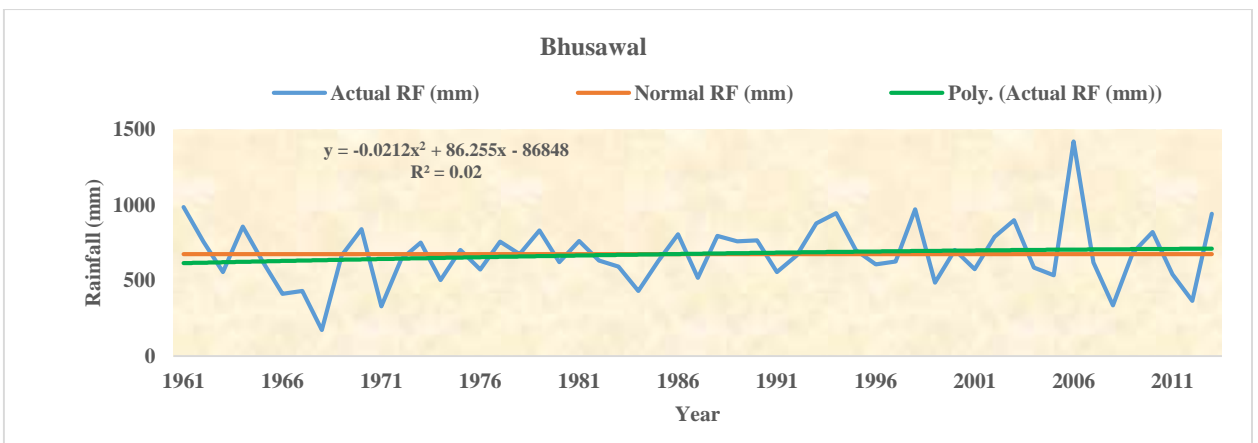


Fig 5: Annual rainfall of Bhusawal tahasil (1961-2016)

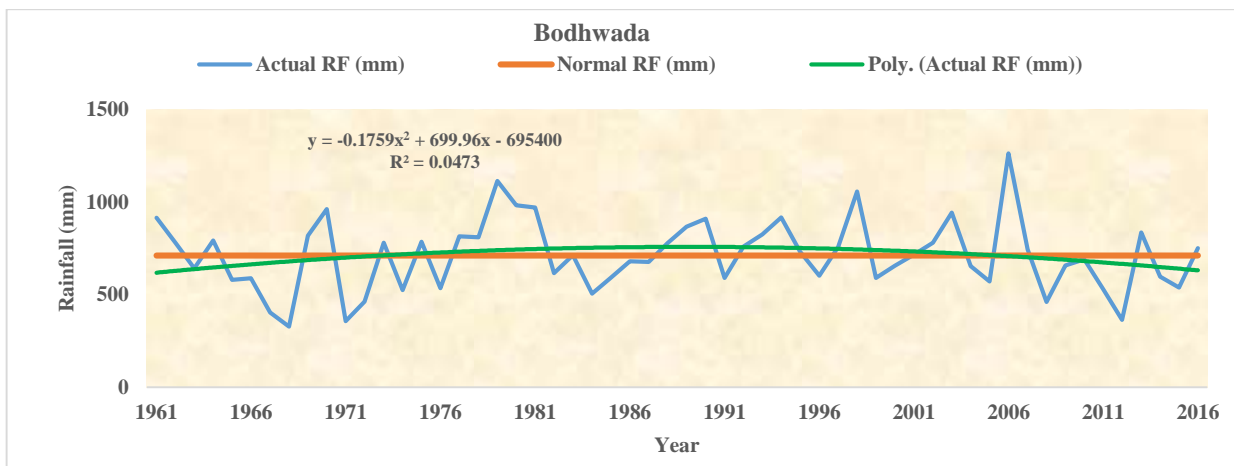


Fig 6: Annual rainfall of Bodhwada tahasil (1961-2016)

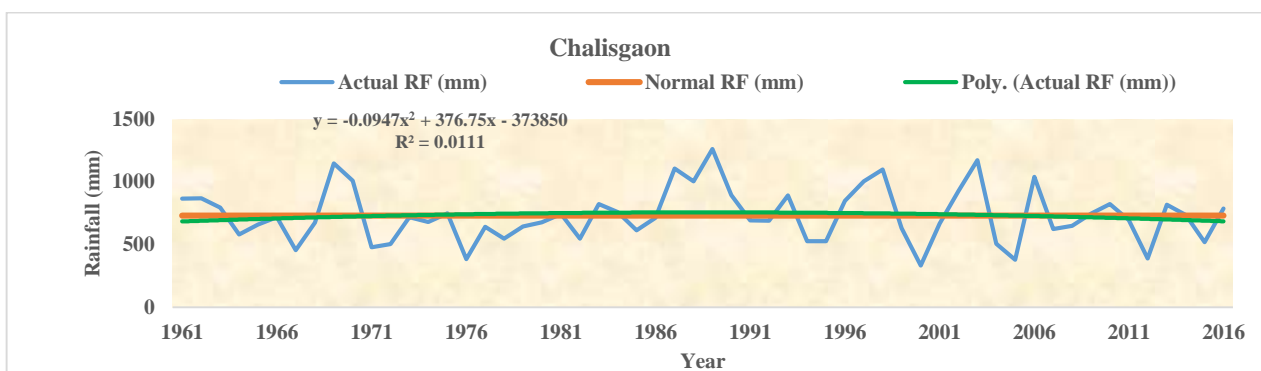


Fig 7: Annual rainfall of Chalisgaon tahasil (1961-2016)

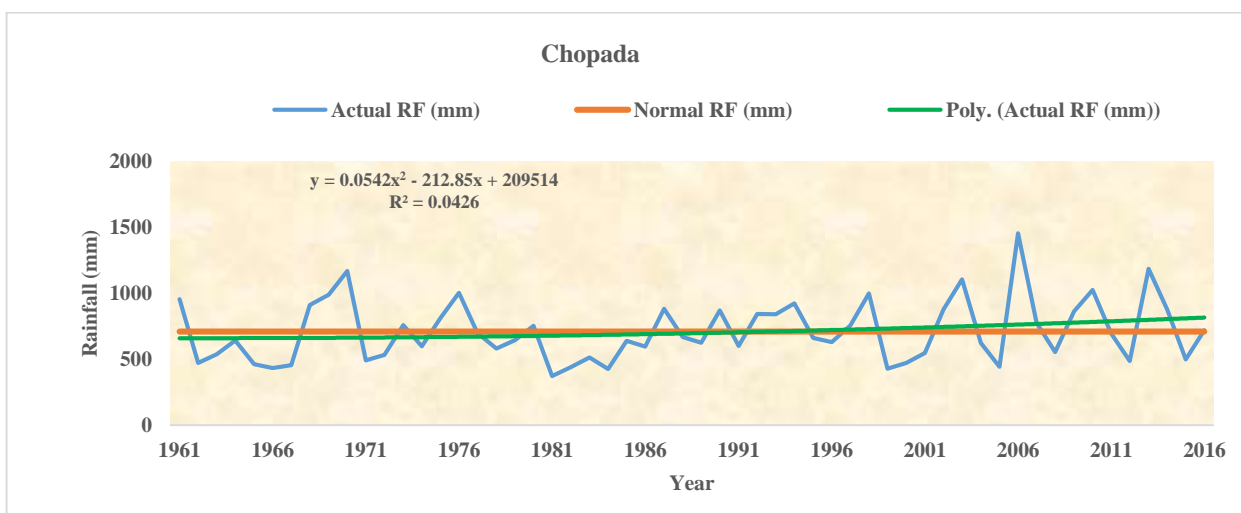


Fig 8: Annual rainfall of Chopada tahasil (1961-2016)

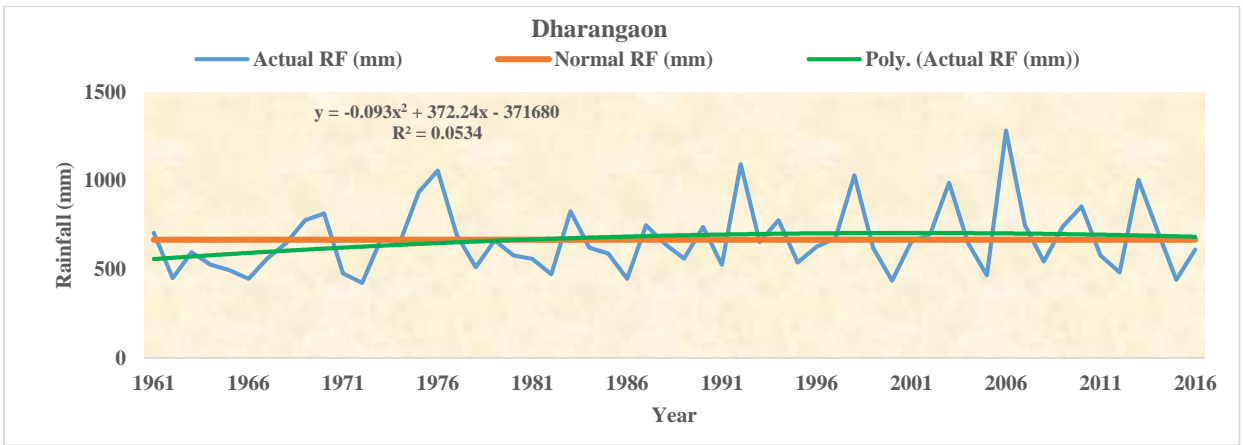


Fig 9: Annual rainfall of Dharangaon tahasil (1961-2016)

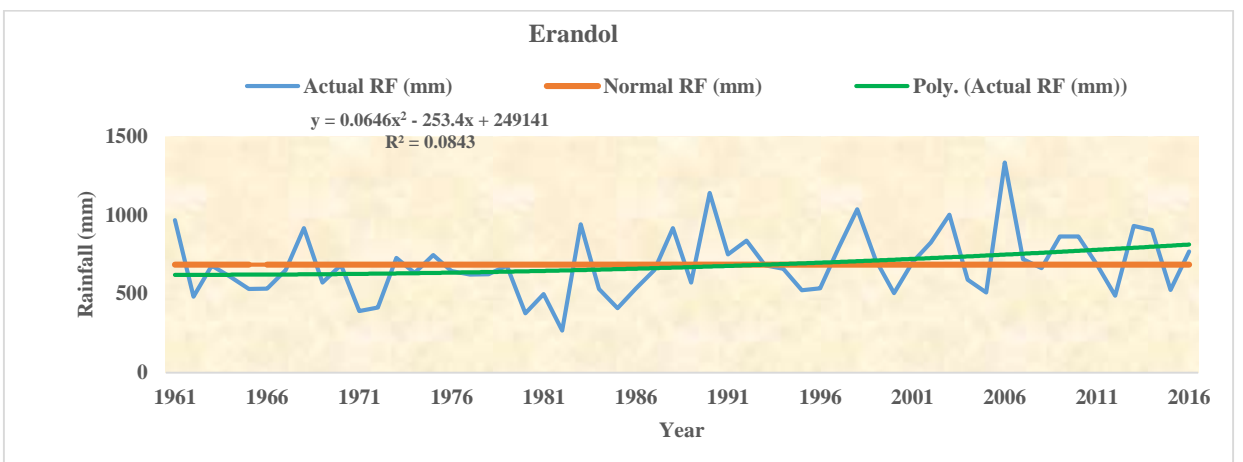


Fig 10: Annual rainfall of Erandol tahasil (1961-2016)

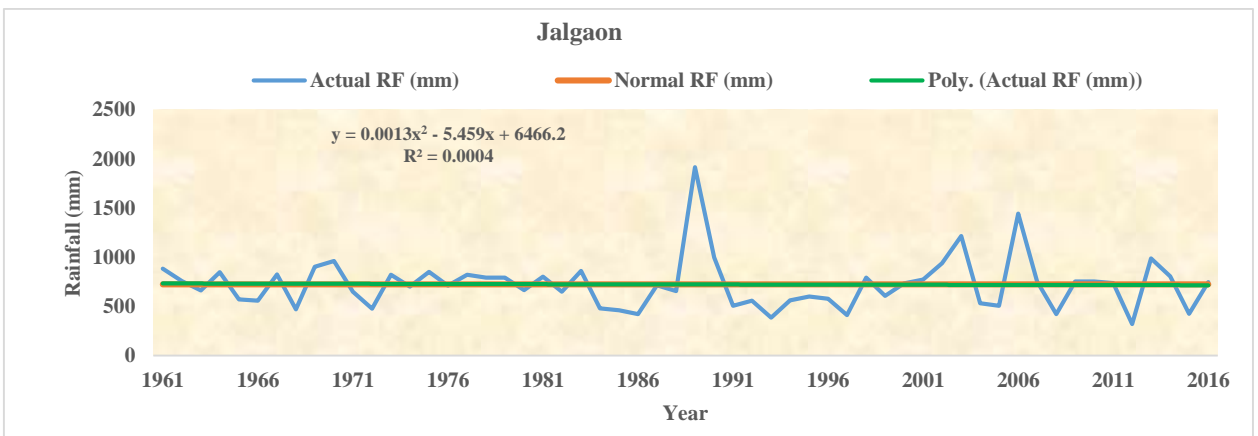


Fig 11: Annual rainfall of Jalgaon tahasil (1961-2016)

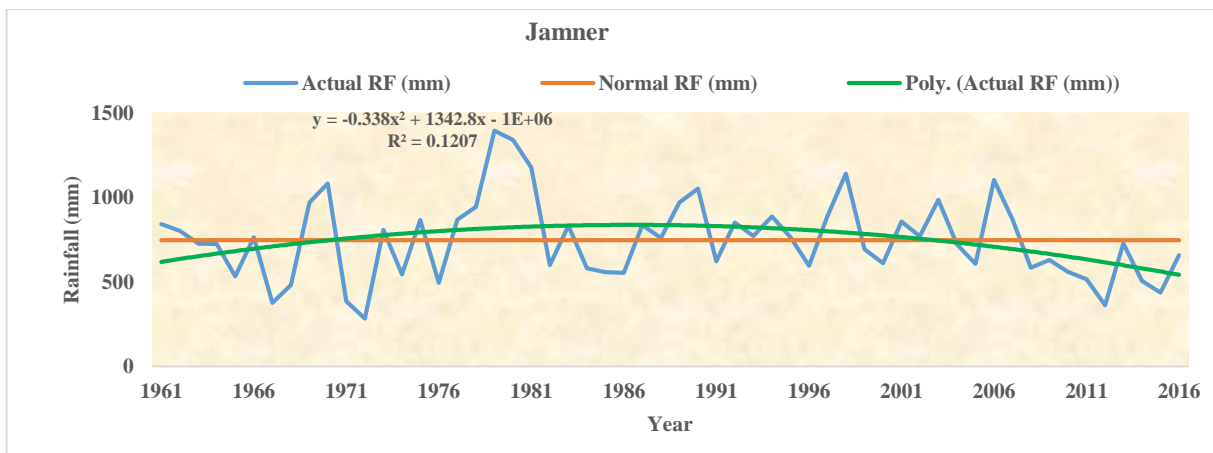


Fig 12: Annual rainfall of Jamner tahasil (1961-2016)

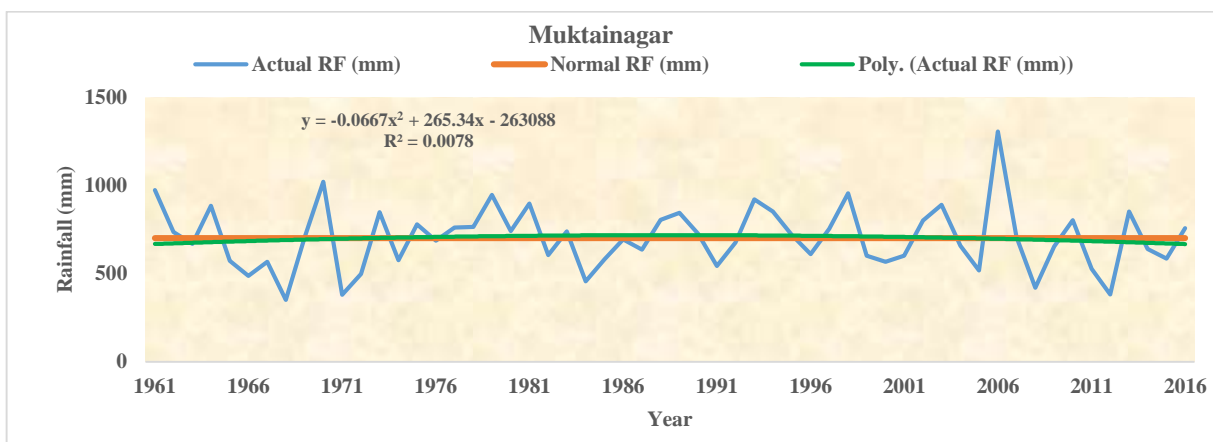


Fig 13: Annual rainfall of Muktainagar tahasil (1961-2016)

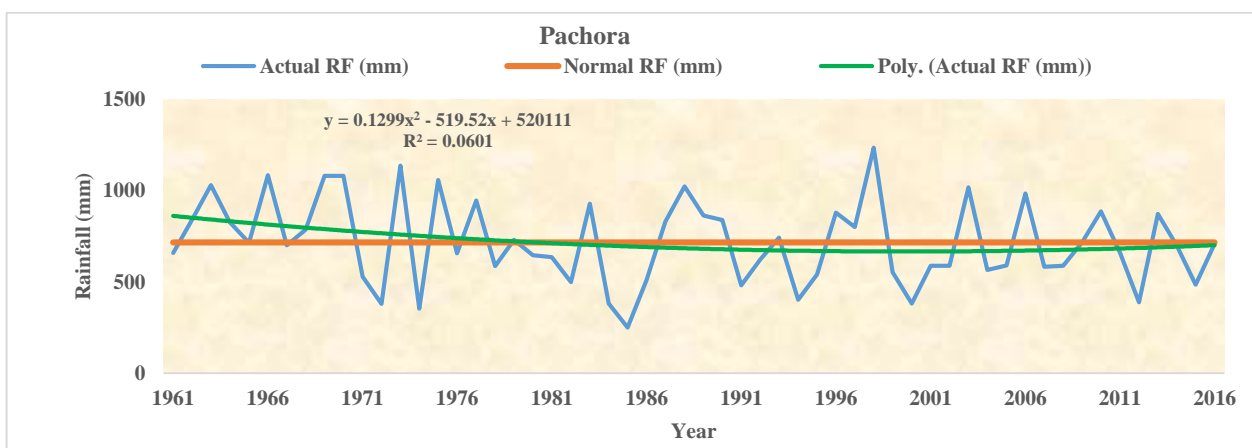


Fig 14: Annual rainfall of Pachora tahasil (1961-2016)

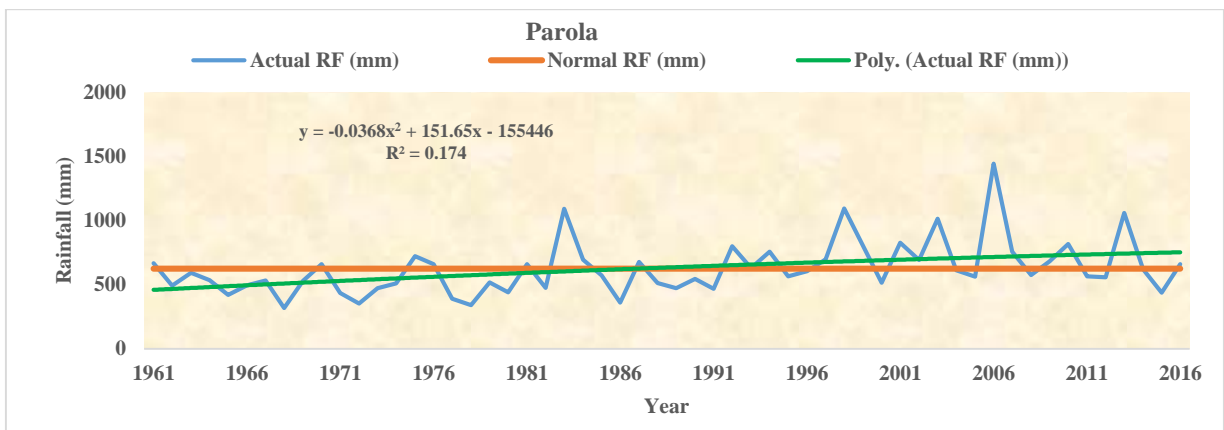


Fig 15: Annual rainfall of Parola tahasil (1961-2016)

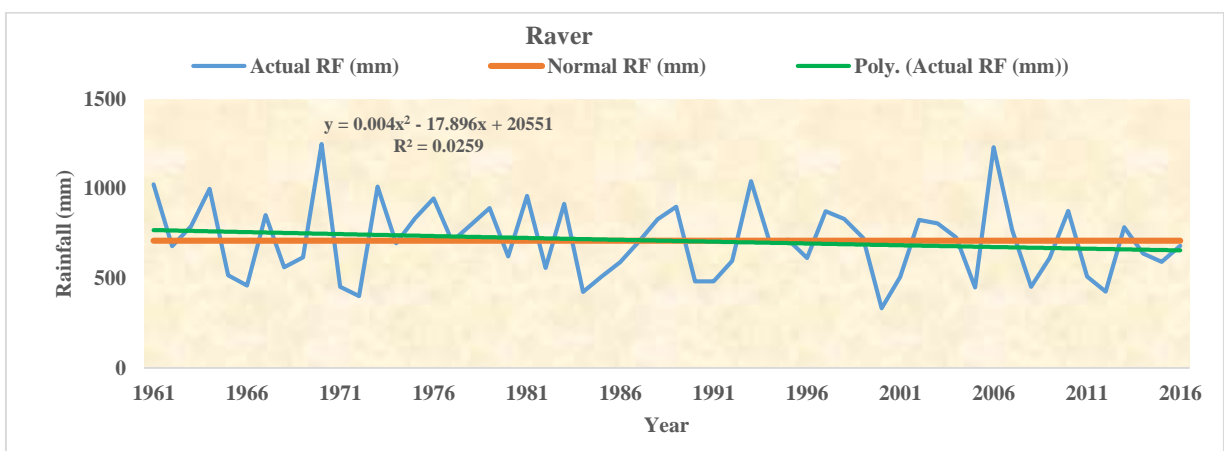


Fig 16: Annual rainfall of Raver tahasil (1961-2016)

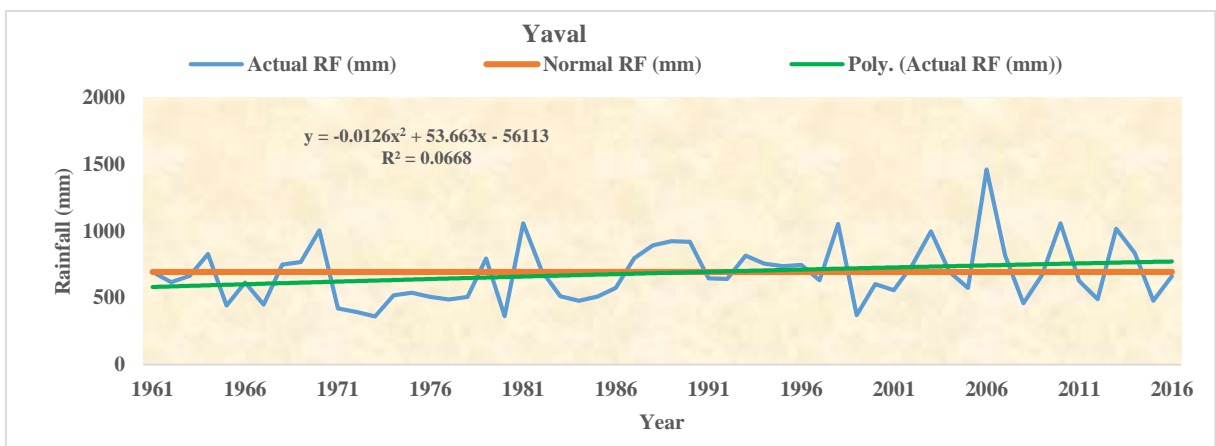


Fig 17: Annual rainfall of Yaval tahasil (1961-2016)

4.3. Seasonal Rainfall Variability:

The data pertaining to tahasilwise seasonal rainfall analysis are presented in Table 3 and depicted in figures 4.1 to 4.4. The seasonwise rainfall was analyzed for South-West, North-East, Summer and Winter seasons according to the tahasils of Ahmednagar district. The rainfall was observed in all the seasons. However, average rains received from South-West rainfall was 575.5 mm of rainfall, which contributed 87.64 per cent over the period of 56 years, followed by North-East rains received 64.9 mm contributing 9.88 per cent, summer rains received 10.8 mm rainfall contributing 1.64 per cent and winter rains received 5.4 mm rainfall contributing 0.82 per cent of annual rainfall. This revealed and confirmed that the South-West rainfall played major role with respect to the contribution of rainfall.

The mean rainfall for the period of 56 years was 698.7 mm with 33.7 per cent coefficient of variation, while least variation was observed in South-West rainy season followed by North-East, which means the distribution of rainfall during the South-West season is more even as compared to the other seasons.

The tahasilwise mean seasonal rainfall was found maximum in Jamner (748.2 mm) followed by Chalisgaon (731.6 mm), Bhadagaon (729.6 mm), Jalgaon (723.4 mm), Pachora (716.4 mm), Dharangaon (712.1 mm), Chopada (711.5 mm), Raver (711.6 mm), Erandol (685.1 mm), Bodwada (683.3 mm), Yawal (681.9 mm), Muktainagar (681.2 mm), Bhusawal (675.1 mm), Amalner (676.1 mm) and Parola(623.1). This reveals that though heavy rains near the Sahyadris in Chalisgaon and plentiful in the central parts of Chopada Dhargaon and Erandol, the rainfall was uncertain. This was because of the variation in topography of all the tahasils.

4.3.1. South-West Monsoon:

It was observed that the rainfall received from South-West monsoon was highest in Jamner (663.5 mm rainfall with 33.7 per cent variation), Bhadagaon (645.9 mm rainfall with 33.52 per cent variation), Chopada (645.0 mm rainfall with 34.89 per cent variation), Chalisgaon (633.8 mm with 30.98 per cent variation), Pachora (632.3 mm rainfall with 34.89 per cent), Bodhwada (630.9 mm rainfall with 29.69 per cent variation), Bhadagaon (645.9 mm rainfall with 33.52 per cent variation), Jalgaon (621.8 mm rainfall with 32.51 per cent variation), Mukatinagar (618.2 mm rainfall with 28.21 per cent variation), Erandol (611.9 mm rainfall with 31.12 per cent variation), Yawal (610.7 mm rainfall with 35.65 per cent variation), Bhusawal (598.4 mm rainfall with 32.64

per cent variation), Dharangaon (593.7 mm rainfall with 29.94 per cent variation), Amalner (590.1 mm rainfall with 40.46 per cent variation) and Parola (546.0 mm rainfall with 35.31 per cent variation) . This trend shows rainfall variation due to agroclimatic conditions and topographical differences.

4.3.2. North –East Monsoon:

The rainfall received from North-East monsoon showed the highest rainfall in Jalgaon (84.5 mm rainfall with 207.73 per cent variation), followed by Chalisgaon (79.2 mm with 90.92 per cent variation), Raver (70.2 mm with 95.65 per cent variation), Bhadagaon (67.8 mm with 92.9 per cent variation), Jamaner (66.7 mm rainfall with 108.18 per cent variation), Pachora (66.2 mm with 92.92 per cent variation), Mukatainagar (64.6 mm with 91.95 per cent variation), Parola (63.5 mm with 99.84 per cent variation), Amalner (62.9 mm with 89.27 per cent variation), Bodhwada (62.6 mm with 133.7 per cent variation), Bhusawal (60.0 mm with 112.17 per cent variation), Dharangaon (59.5 mm with 82.63 per cent variation), Erandol (58.9 mm with 108.29 per cent variation), Yawal (54.7 mm with 89.83 per cent variation) and Chopada (51.9 mm with 95.25 per cent variation). Hence, this distribution of rainfall showed that the North-East rainfall was highest in Soth-Eastern part of Jalgaon district and lowest in Northern part of Jalgaon. The variation in rainfall may be due to agroclimatic conditions and topographical differences.

4.3.3. Summer and Winter Season Rainfall:

Rainfall received from winter and summer season were negligible as compared to other two seasons. However, summer showers were highest in Chalisgaon recorded 13.2 mm with 156.68 per cent variation and Jalgaon recorded 12.5 mm rainfall with 141.6 per cent variation over other tahasils. The winter showers were the highest in Bhusawal recorded 7.5 mm rainfall with 279.36 per cent variation and Pachora recorded 6.8 mm rainfall with 195.9 per cent variation over other tahasils. Thus, this rain was useful for *rabi* cropping. The summer showers were important from preparatory tillage point of view.

Hence, it was concluded that South-West (June to September) monsoon season plays an important role in all the tahasils of Jalgaon district, which gave assured rainfall during *kharif* crops of different growing periods such as short duration and medium duration crops that could be safely be grown under rainfed cropping system. However, the good quantum of rainfall received in North-East (October to December) monsoon season (post-monsoon) helped in proper establishment and early growth of rainfed *rabi* crops.

Similar study of seasonal rainfall variability carried out by Raghavan (1964) of coastal boundary of peninsular India, Deka and Nath (2000) in upper Brahmaputra valley zone of Assam.

Table 4.3: Tahasilwise seasonal rainfall (mm) variation in Jalgaon district (1961-2016)

Tahasil	Season wise rainfall (mm) and coefficient of variation (%)														
	Winter			Summer			South-West			North -East			Total (mm)		
	RF	S. D.	C. V. (%)	RF	S. D.	C. V. (%)	RF	S. D.	C. V. (%)	RF	S. D.	C. V. (%)	(Jan-Dec)	S. D.	C. V. (%)
Amalner	4.3	10.82	253.59	9.8	14.37	146.90	590.1	238.80	40.46	62.9	56.18	89.27	667.1	257.78	38.64
Bhadagaon	6.4	13.82	214.57	9.4	18.80	199.80	645.9	216.52	33.52	67.8	63.00	92.9	729.6	219.06	30.03
Bhodwada	6.5	15.18	232.25	10.9	17.90	164.06	630.9	187.3	29.69	62.6	83.72	133.77	683.3	285.91	41.85
Bhusawal	7.4	20.82	279.36	9.4	18.03	192.09	598.3	195.32	32.64	59.9	67.56	112.69	675.1	199.24	29.51
Chalisgaon	5.4	10.49	194.49	13.2	20.69	156.68	633.8	196.35	30.98	79.2	72.03	90.93	731.6	212.20	29.00
Chopada	3.7	6.10	163.63	10.9	21.37	196.13	645.0	225.01	34.89	51.9	49.43	95.25	711.5	231.85	32.59
Dharangaon	4.3	7.62	176.83	9.8	13.74	140.09	593.7	177.74	29.94	59.5	49.14	82.63	712.1	303.6	42.63
Erandol	3.9	8.54	216.52	10.2	18.13	176.98	611.9	190.44	31.12	58.9	63.82	108.29	685.0	202.96	29.63
Jalgaon	4.6	8.19	178.69	12.5	17.65	141.60	621.8	202.19	32.51	84.5	175.49	207.73	723.4	263.34	36.40
Jamner	5.6	14.13	251.62	12.4	23.7	190.58	663.5	223.61	33.7	66.7	72.12	108.18	748.2	238.58	31.89
Muktainagar	6.5	13.02	201.44	10.6	15.97	150.60	618.2	174.42	28.21	64.5	59.36	91.95	681.2	246.88	36.24
Pachora	6.8	13.32	195.09	11.1	21.29	191.25	632.3	220.58	34.89	66.2	61.48	92.92	716.4	230.49	32.17
Parola	4.9	10.44	211.27	8.7	15.99	183.07	546.0	192.80	35.31	63.5	63.37	99.84	623.1	209.31	33.59
Raver	5.3	13.05	247.16	11.2	19.96	178.41	624.4	192.72	30.86	70.2	67.13	95.66	711.1	208.67	29.35
Yawal	4.8	9.96	206.08	12.3	21.48	174.98	610.1	217.48	35.65	54.7	49.18	89.83	681.9	218.93	32.10
District mean	5.4	11.70	214.80	10.8	18.60	172.20	575.5	189.80	43.70	64.9	70.20	106.1	656.6	235.30	33.70
Per cent contribution to total rainfall	0.82			1.64			87.64			9.88			100		

4.4. Seasonal Rainy Days Variation:

The number of rainy days are important tool for the study of duration of rainfall in a particular region and its effect on various crop growth stages. The data of tahasilwise seasonal rainy days are presented in Table 4. The seasonwise rainy days were analyzed for South-west, North-east, Summer and Winter seasons according to tahasils. More number of rainy days were observed in South-west and North-east seasons and negligible during winter and summer season. However, mean number of rainy days received from South-west monsoon was 38 rainy days which contributed 93.24 per cent of annual rainy days for 56 years, while the rainy days from North-east monsoon were rainy 4 days contributed 9.45 per cent and the rainy days from Summer and Winter showers were negligible.

The average number of rainy days were 41 rainy days. The total rainy days recorded from all the seasons was the highest in Jalgaon and Parola (43 days), Chalisgaon, Chopada and Pachora (42 days), Bhadagaon, Jamner, Raver and Yawal (41 days), Dharangaon and Erandol (40 days), Bhusawal (39 days), Amalner and Muktainagar (38), Bodhwada (37 days). Similar study was undertaken by Ugale during 2007 for Beed district of Maharashtra.

The recorded observations showed that the number of rainy days from South-west monsoon were highest in Dharangaon (46 days) followed by Muktainagar (45 days), Bodhawada (42 days), Chalisgaon, Chopada, Jalgaon, Pachora and Parola (37 days), Bhadagaon, Erandol, Jamner and Yawal (36 days), Bhusawal and Raver (35 days), Amalner (34 days). This revealed that rainy days were the highest in ghat zone and decreased in scarcity zone of Ahmednagar district.

North-east monsoon had recorded second highest number of rainy days. The highest number of rainy days received from North-east monsoon were in Dharangaon (5 days), Amalner, Bodhawada, Bhadagaon, Chalisgaon, Jalgaon, Mukatainagar, Pachora, Parola and Raver (4 days) for each, Bhusawal, Chopada, Erandol, Jamner and Yawal 3 rainy days each.

The rainy days of summer and winter showers had negligible contribution. The highest numbers of rainy days from summer showers were only one days in all tahasils. These rainy days are important from the preparatory tillage operations point of view. Thus, South-west monsoon had greater contribution of rainy days followed by North-east monsoon. Similar trend was noted by Deka *et al.* (2000), Gare *et al.* (2000), Parmar *et al.* (2005) and Singh *et al.* (2009) for Assam, Gadhinglaj (Maharashtra), Gujarat and Bihar respectively. Shaikh *et al.* (2018 b) reported similar finding on Satara district of Maharashtra state.

Table 4.4: Tahasilwise seasonal rainy days (numbers) variation in Jalgaon district (1961-2016)

Tahasil	Season wise rainy days (numbers) and coefficient of variation (%)														
	Winter			Summer			South-West			North-East			Total (Nos.)		
	RD	S. D.	C. V. (%)	RD	S. D.	C. V. (%)	RD	S. D.	C. V. (%)	RD	S. D.	C. V. (%)	(Jan-Dec)	S. D.	C. V. (%)
Amalner	2	1.06	237.52	1	1.02	139.02	34	7.77	23.16	4	2.81	77.82	38	8.69	22.64
Bhadgaon	0	0.69	204.79	1	1.29	164.09	36	8.21	22.67	4	3.21	85.58	41	9.38	22.83
Bhodwad	2	204.99	1.06	1	146.61	1.73	42	21.35	9.05	4	82.54	3.45	37	13.3	35.63
Bhusawal	0	1.14	266.44	1	1.56	174.4	35	9.18	26.14	3	2.7	89.05	39	8.9	22.54
Chalisgaon	1	0.85	198.28	1	1.31	135.52	37	9.05	24.63	4	3.54	85.42	42	9.81	23.2
Chopada	2	0.76	170.43	1	1.37	163.49	37	8.59	23.32	3	2.74	80.8	42	9.39	22.62
Dharangaon	1	171.96	0.95	1	121.33	1.52	46	19.48	9.01	5	77.92	3.94	40	14.9	37.3
Erandol	0	0.64	188.74	1	1.28	171.03	36	8.2	22.83	3	2.84	84.29	40	8.38	20.75
Jalgaon	1	0.95	171.96	1	1.67	126.72	37	8.16	22.01	4	3	81.06	43	8.59	20.13
Jamner	1	0.75	200.61	1	1.49	166.37	36	7.57	20.85	3	3.24	92.93	41	8.38	20.42
Muktainagar	1	201.66	1.04	1	131.45	1.64	45	22.88	10.27	4	81.6	3.64	38	8.19	21.41
Pachora	0	0.58	171.19	1	1.13	146.9	37	8.76	23.72	4	3.08	81.33	42	10.12	24.18
Paroala	0	0.81	180.82	1	1.07	142.13	37	7.85	21.04	4	3.7	90.11	43	8.56	20.07
Raver	1	0.93	217.33	1	1.32	167.65	35	8.29	23.44	4	3.05	76.54	41	9.23	22.76
Yaval	0	0.65	165.88	1	1.73	182.92	36	8	22.1	3	2.72	79.81	41	8.67	21.19
District mean	1			1			38			4			41		
Per cent contribution to total rainfall	2.12			2.32			93.24			9.45			100		

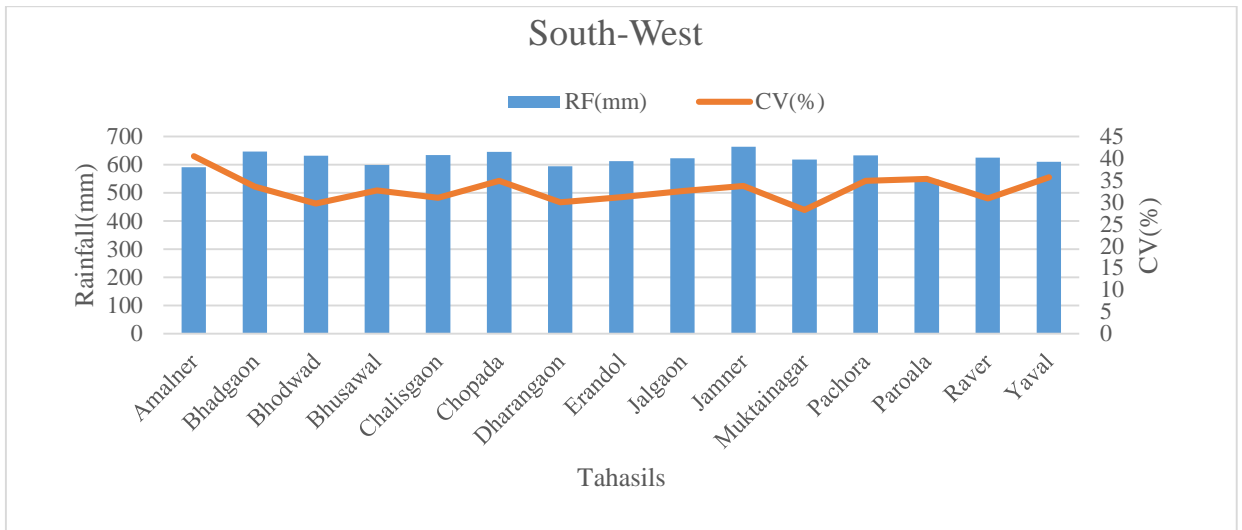


Fig 18: Tahasilwise rainfall variation by South-West monsoon (1961-2016)

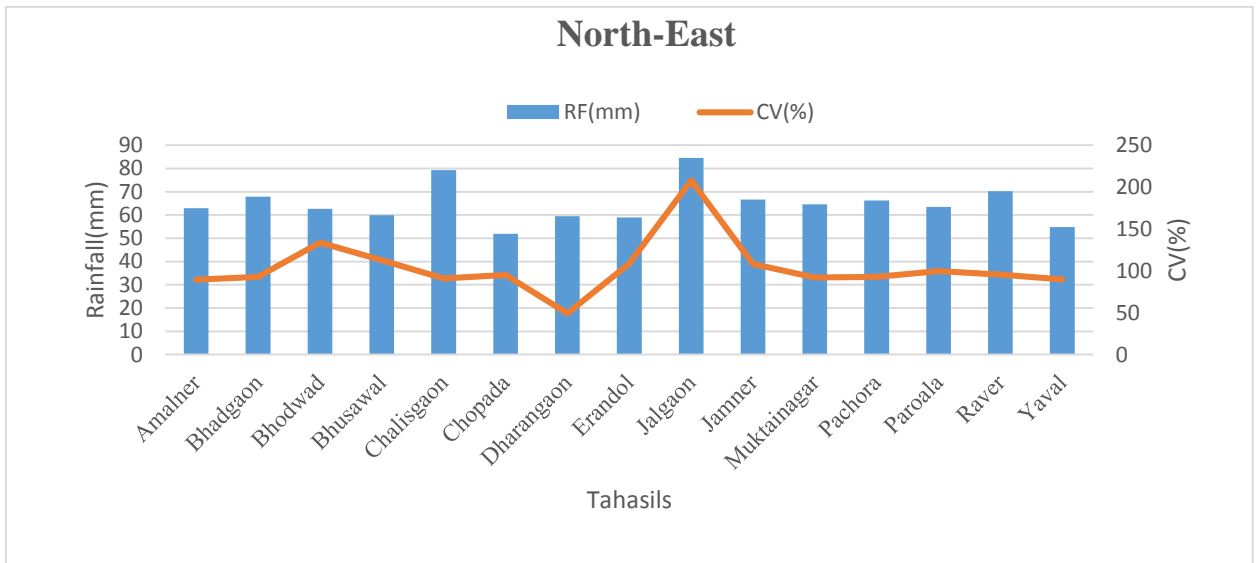


Fig 19: Tahasilwise rainfall variation by North-East monsoon (1961-2016)

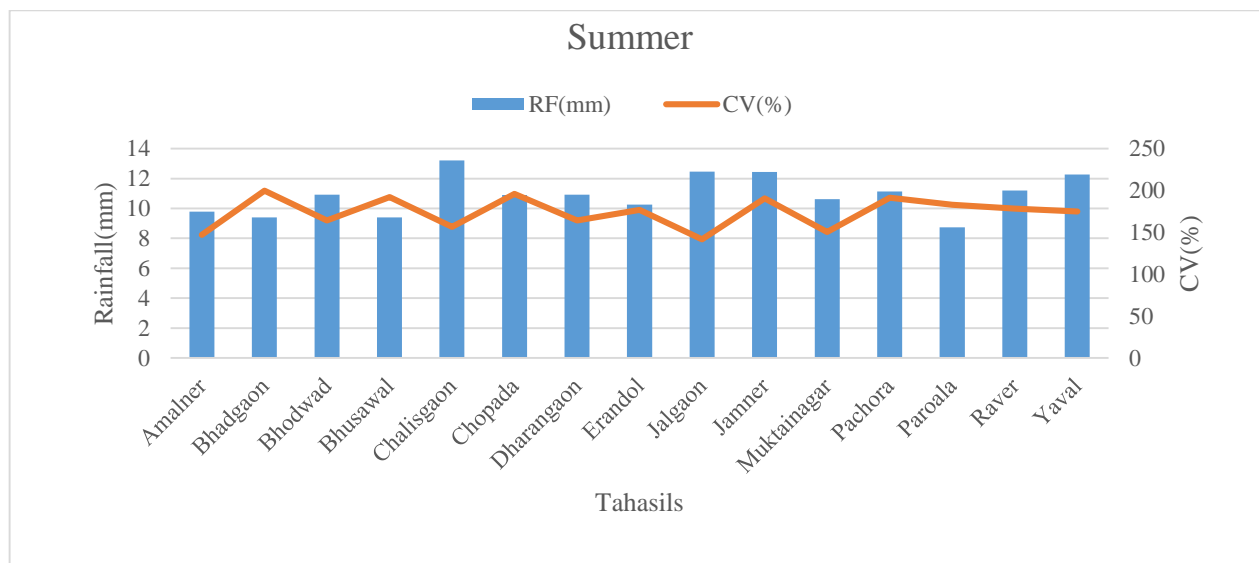


Fig 20: Tahasilwise rainfall variation by Summer rainfall (1961-2016)

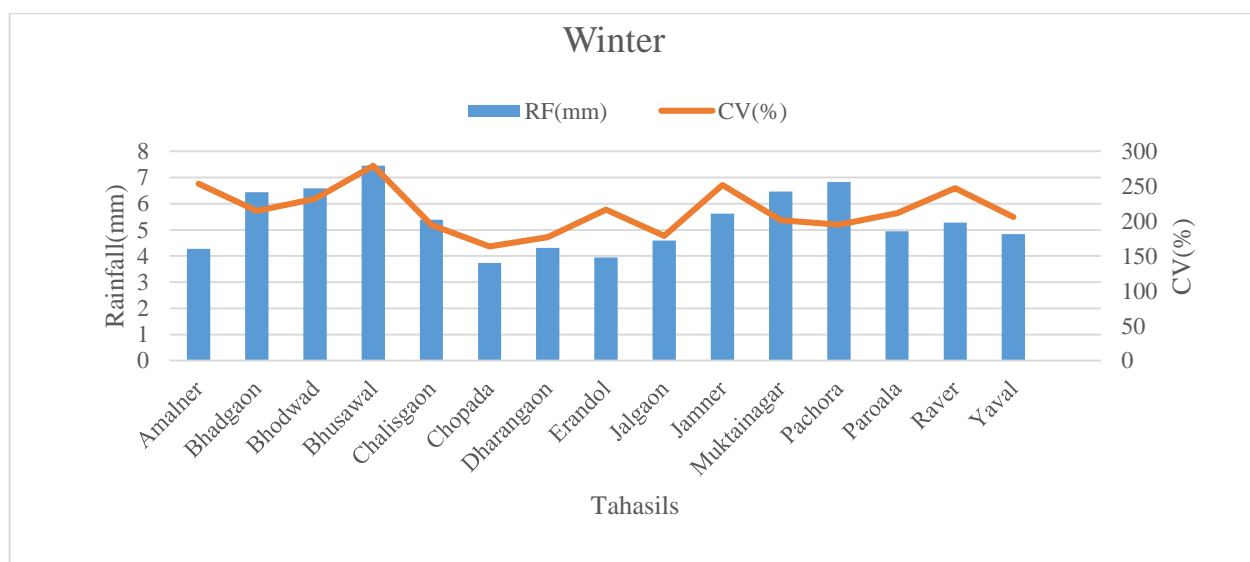


Fig 21: Tahasilwise rainfall variation by Winter rainfall (1961-2016)

4.5. Monthly Rainfall Variability:

There was significant deviation in the monthly rainfall variability across the district and the tahasils particularly. The data are presented in Table 5 and depicted in figures from 5.1 to 5.15. Only annual rainfall is not an ideal tool for selection of cropping sequence to be adopted for a particular location. For that the trend of monthly frequencies of rainfall of a location seems to be ideal for delineating the cropping pattern to be suggested for that particular location.

The rainfall from June to September showed less variation as compared to rainfall received during rest of the months. The average highest monthly rainfall of 165.3 mm was noted during July which contributed to 48.20 per cent of total rainfall in a year and was followed by August receiving 165.0 mm with 57.47 per cent contribution. It was observed that June, July, August and September months received more quantum of rainfall noting 109.5 mm (66.61 per cent contribution), 165.3 mm (48.20 per cent contribution), 165.0 mm (57.47 per cent contribution) and 112.3 mm (66.22 per cent contribution), respectively. There was less variation in rainfall for all the tahasils during June to July months. The contribution and quantum of the rainfall was highest in July month over all the other months, which may have played an important role for boosting the *Kharif* cropping in Jalgaon district.

Amongst all the 15 tahasils of Jalgaon district, it was observed that the rainfall was well distributed from June to October. The contribution of rainfall was also significant over rest of the months. It was revealed that all the tahasils received highest rainfall in the month of July. Hence, such rains are useful for *Kharif* cropping.

As far as tahasilwise monthly rainfall variability was considered the highest rainfall was received at Chopada (231.4 mm with 30.0 per cent contribution and 54 per cent variation) followed by Jamner (213.4 mm with 28.5 per cent contribution and 56.39 per cent variation), Pachora (206.5 mm with 28.8 per cent annual rainfall contribution and 55.92 per cent variation), Bhadagon (1203.2 mm rainfall with 27.9 per cent contribution 53.67 per cent variation), Yawal (199.8 mm rainfall with 29.3 per cent contribution and 49.35 per cent variation), Jalgaon (197.6 mm rainfall with 27.3 per cent contribution and 45.06 per cent variation), Amelner (195.8 mm rainfall with 29.3 per cent contribution with 70.9 per cent variation), Bhusawal (195.5 mm rainfall with 29.0 per cent contribution and 48.17 per cent variation), Erandol (194.8 mm with 28.4 per cent and 47.74 per cent contribution), Bodhwada (193.0 mm with 27.1 per cent contribution and 39.38 per cent variation), Dharangaon (192.9 mm with 28.9 per cent contribution and 43.99 per cent variation), Raver (190.8 mm with 26.8 per cent contribution and 57.15 per cent variation), Mukatainagar (190.3 mm with 27.2 per cent contribution and 41.85 per cent variation), Chalisgaon (179.3 mm with 24.5 per cent contribution and 56.61 per cent variation) and Parola (169.8 mm with 27.2 per cent contribution and 42.99 per cent variation). All the tahasils received the highest rainfall in the month of September.

The lowest rainfall was received in Yawal (1.9 mm), Parola (1.6 mm) followed by Jalgaon (1.4 mm), Chopada (1.3), Mukatainagar (1.1 mm), Raver (0.9 mm), Bodhwada (0.9 mm), Pachora (0.7 mm), Jamner (0.3 mm), Chalisgaon (0.2 mm), Bhusawal and Dharangaon (0.2mm), Bhadagaon received 0.1 mm and Erandol received 0.1 mm in April. Amalner received 1.4 mm in January.

The data revealed that the major portion of rainfall was concentrated during June, July, August and September months. However, a good quantum of rainfall was also recorded in the month of October. During the early months of year i.e. January to May as well as month of November and December a very meager amount of rainfall was recorded in almost all the tahasils.

These periods coincide with different crops either in their later vegetative growth stages and favors the crop to grow under adequate moisture availability. The rainfall received in the month of October seems to be helpful for timely sowing of *rabi* crops and proper establishment of sown crops under stored soil moisture particularly in heavy textured soils. The variability of rainfall showed a very narrow range variation during the month of June, July, August and September in almost all the tahasils. Similar work was undertaken by Reddy *et. al* (2007 b), Krishnakaumar and Rao (2008) , Sahoo *et. al* (2008), Chand *et. al* (2010) and Shaikh *et al.* (2017 b) for Andhra Pradesh, Kerala, Udhagmandalam, Jhansi (Uttar Pradesh) and Satara (Maharashtra) respectively.

Table 4.5: Tahasilwise monthly rainfall (mm) variation in Jalgaon district (1961-2016)

Month	Tahasil															
	Amalner				Bhadagaon				Bhodwada				Bhusawal			
	RF (mm)	Cont. (%)	S. D.	C. V. (%)	RF (mm)	Cont. (%)	S. D.	C. V. (%)	RF (mm)	Cont. (%)	S. D.	C. V. (%)	RF (mm)	Cont. (%)	S. D.	C. V. (%)
January	1.4	0.2	3.63	267.89	3.0	0.4	8.68	287.27	2.8	0.4	9.81	348.42	2.2	0.3	7.05	318.04
February	2.9	0.4	10.25	351.82	3.4	0.5	11.17	326.89	3.7	0.5	11.38	306.13	5.2	0.8	19.65	375.31
March	4.7	0.7	10.34	219.8	4.0	0.6	11.01	275.11	4.3	0.6	9.64	224.95	3.2	0.5	9.15	289.35
April	1.8	0.3	5.99	324.78	0.7	0.1	3.05	432.72	0.9	0.1	2.99	339.69	1.5	0.2	5.32	363.91
May	3.2	0.5	8.60	266.07	4.7	0.6	15.67	335.43	5.8	0.8	12.03	214.08	4.8	0.7	9.63	202.15
June	112.8	16.9	75.48	66.92	125.9	17.3	74.75	59.37	127.0	17.8	80.84	63.66	122.3	18.1	87.08	71.23
July	195.8	29.3	138.81	70.90	175.3	24.0	76.55	43.66	193.0	27.1	76.01	39.38	195.5	29.0	94.14	48.17
August	167.9	25.2	96.65	57.55	203.2	27.9	109.05	53.67	191.6	26.9	106.76	55.71	169.9	25.2	107.66	63.36
September	113.6	17.0	78.93	69.46	141.5	19.4	93.58	66.15	119.3	16.8	77.89	65.29	110.7	16.4	82.07	74.13
October	40.0	6.0	49.53	123.85	40.7	5.6	46.02	113.57	39.4	5.5	48.65	123.42	38.2	5.7	54.71	143.37
November	17.2	2.6	33.31	193.64	18.3	2.5	37.94	207.52	16.9	2.4	33.07	195.42	13.7	2.0	32.26	235.05
December	5.7	0.9	14.79	257.47	8.9	1.2	18.27	206.25	7.0	1.0	18.54	265.97	8.1	1.2	20.67	256.04
Total	667.1	100.0			729.6	100.0			711.7	100.0			675.1	100.0		
Highest	195.8				203.2				193.0				195.5			
Month	July				August				July				July			
Lowest	1.4				0.1				0.9				0.2			
Month	Jan				April				April				April			

Table 5 contd...

Table 4.5: Tahasilwise monthly rainfall (mm) variation in Jalgaon district (1961-2016)

Month	Tahasil															
	Chalisgaon				Chopada				Dharangaon				Erandol			
	RF (mm)	Cont. (%)	S. D.	C. V. (%)	RF (mm)	Cont. (%)	S. D.	C. V. (%)	RF (mm)	Cont. (%)	S. D.	C. V. (%)	RF (mm)	Cont. (%)	S. D.	C. V. (%)
January	2.8	0.4	7.36	264.03	1.5	0.2	4.01	262.37	1.7	0.3	4.05	231.89	1.7	0.2	4.18	244.92
February	2.6	0.4	8.00	306.73	2.2	0.3	4.94	225.00	2.6	0.4	6.13	238.77	2.2	0.3	7.79	348.00
March	5.4	0.7	15.87	294.64	3.1	0.4	10.11	322.05	3.5	0.5	7.47	216.87	3.9	0.6	12.66	323.21
April	0.2	0.0	1.23	574.76	1.3	0.2	4.65	372.77	1.6	0.2	3.73	241.05	0.5	0.1	2.11	433.45
May	7.6	1.0	15.08	198.27	6.5	0.9	15.46	237.03	4.8	0.7	10.45	217.14	5.8	0.9	12.82	219.43
June	123.3	16.8	81.22	65.09	124.9	17.6	87.62	70.17	114.5	17.2	62.99	55.03	118.5	17.3	68.75	58.02
July	155.8	21.3	85.83	55.09	213.4	30.0	115.22	54.00	192.9	28.9	84.87	43.99	194.8	28.4	92.98	47.74
August	175.4	24.0	98.31	56.04	192.4	27.0	118.03	61.49	173.0	25.9	83.88	48.49	191.5	28.0	107.41	56.09
September	179.3	24.5	101.52	56.61	114.3	16.1	81.45	71.23	113.3	17.0	68.61	60.55	107.1	15.6	87.48	81.66
October	53.1	7.3	57.59	108.38	33.9	4.8	38.03	112.35	38.9	5.8	38.89	100.02	39.0	5.7	50.24	128.89
November	20.0	2.7	40.00	200.43	13.1	1.8	27.38	209.46	15.0	2.2	27.96	186.66	13.3	1.9	32.81	247.22
December	6.1	0.8	15.39	251.22	5.0	0.7	13.19	265.29	5.6	0.8	13.52	240.88	6.7	1.0	18.99	283.93
Total	731.7	100.0			711.51	100.0			667.3	100.0			685.0	100.0		
Highest	179.3				231.4				192.9				194.8			
Month	September				July				July				July			
Lowest	0.2				1.3				1.6				0.1			
Month	April				April				April				April			

Table 5 contd...

Table 4.5: Tahasilwise monthly rainfall (mm) variation in Jalgaon district (1961-2016)

Month	Tahasil															
	Jalgaon				Jamner				Muktainagar				Pachora			
	RF (mm)	Cont. (%)	S. D.	C. V. (%)	RF (mm)	Cont. (%)	S. D.	C. V. (%)	RF (mm)	Cont. (%)	S. D.	C. V. (%)	RF (mm)	Cont. (%)	S. D.	C. V. (%)
January	2.4	0.3	4.44	182.58	3.4	0.5	13.21	386.63	2.4	0.3	6.27	264.18	3.4	0.5	9.72	285.02
February	2.2	0.3	6.29	291.99	2.2	0.3	5.98	271.89	4.1	0.6	11.14	272.52	3.4	0.5	10.17	297.32
March	5.2	0.7	10.43	199.47	5.4	0.7	12.67	234.13	4.4	0.6	9.48	216.69	5.5	0.8	12.73	231.69
April	1.4	0.2	4.58	324.18	0.3	0.0	1.58	531.38	1.1	0.2	3.54	325.29	0.7	0.1	3.02	428.51
May	5.8	0.8	9.72	166.84	6.7	0.9	18.98	282.07	5.1	0.7	8.69	168.92	4.9	0.7	15.76	319.78
June	128.8	17.8	92.78	72.01	131.7	17.6	89.51	67.97	124.1	17.7	78.58	63.3	113.1	15.8	77.09	68.87
July	197.6	27.3	89.03	45.06	190.6	25.5	80.65	42.32	190.3	27.2	79.62	41.85	178.2	24.9	83.23	46.72
August	184.9	25.6	111.02	60.06	213.4	28.5	120.32	56.39	184.2	26.3	99.09	54.22	206.5	28.8	115.49	55.92
September	110.6	15.3	67.98	61.48	127.9	17.1	85.28	66.69	119.6	17.1	72.12	60.31	134.5	18.8	86.59	64.04
October	58.3	8.1	171.78	294.66	40.7	5.4	49.4	121.44	41.8	6.0	47.81	114.42	38.6	5.4	44.71	115.83
November	17.5	2.4	33.45	191.26	20.1	2.7	44.4	220.68	15.2	2.2	29.96	196.09	19.5	2.7	38.00	195.34
December	8.7	1.2	20.78	239.01	5.8	0.8	17.54	298.95	7.5	1.1	17.08	235.72	8.1	1.1	19.98	246.57
Total	723.4	100.0			748.2	100.0			699.8	100.0			716.4	100.0		
Highest	197.6				213.4				190.3				206.1			
Month	July				August				July				August			
Lowest	1.41				0.3				1.1				0.7			
Month	April				April				April				April			

Table 5 contd...

Table 4.5: Tahasilwise monthly rainfall (mm) variation in Jalgaon district (1961-2016)

Month	Tahasil															
	Parola				Raver				Yawal				District Average			
	RF (mm)	Cont. (%)	S. D.	C. V. (%)	RF (mm)	Cont. (%)	S. D.	C. V. (%)	RF (mm)	Cont. (%)	S. D.	C. V. (%)	RF (mm)	Cont. (%)	S. D.	C. V. (%)
January	2.4	0.4	7.19	305.08	2.2	0.3	6.21	284.12	2.73	0.4	8.09	297	21.0	3.47	6.93	281.96
February	2.6	0.4	8.08	312.34	3.1	0.4	9.63	311.02	2.1	0.3	6.62	314.04	23.4	3.87	9.15	303.34
March	2.5	0.4	6.78	271.57	5.4	0.8	12.02	224.18	5.0	0.7	13.55	269.03	18.6	3.07	10.95	254.21
April	1.5	0.2	4.09	315.56	0.9	0.1	4.74	524.46	1.9	0.3	6.05	336.53	35.8	5.92	3.86	391.27
May	4.7	0.8	13.34	285.11	4.8	0.7	11.31	233.53	5.3	0.8	13.89	261.75	20.2	3.34	12.78	240.52
June	105.7	17.0	66.17	62.57	122.9	17.3	92.47	75.22	115.3	16.9	91.00	78.94	109.5	18.08	80.48	66.61
July	169.7	27.2	72.94	42.99	181.8	25.6	94.19	51.82	199.8	29.3	98.61	49.35	165.3	27.30	90.85	48.20
August	158.6	25.5	86.73	54.67	190.8	26.8	109.01	57.17	172.6	25.3	122.78	71.15	165.0	27.27	106.22	57.47
September	111.9	18.0	75.62	67.56	128.9	18.1	80.64	62.57	122.4	17.9	79.08	65.02	112.3	18.56	81.30	66.22
October	42.7	6.9	48.94	114.53	47.4	6.7	54.06	113.98	37.2	5.5	43.03	115.55	43.2	7.1418	56.24	129.62
November	14.6	2.3	29.01	198.16	15.0	2.1	35.36	235.59	9.3	1.4	19.62	211.96	29.8	4.93	32.97	208.35
December	6.1	1.0	19.08	313.42	7.7	1.1	18.61	240.41	8.3	1.2	16.48	199.78	21.9	3.62	17.58	253.40
Total	623.1	100.0			711.1	100.0			681.9	100			605.2			
Highest	169.7				190.8				199.8				165.3			
Month	July				August				July				July			
Lowest	1.5				0.9				1.9				20.2			
Month	April				April				April				May			

4.6. Monthly Rainy Days:

There was significant variation in the monthly rainy days. The data of monthly rainy days are presented in Table 6. Variation in the rainy days is most useful for the scheduling the crop life cycle *i.e.* from sowing to harvesting. The data from the table showed that the average rainy days of all the tahasils of Jalgaon district were 44 rainy days with 117.1 per cent variation. The average highest number of rainy days were 12 rainy days in the month of July, followed by 11 rainy days in August, 7 rainy days in June and September. While the least number of rainy days *i.e.* 0, 1 and 2 days were observed in rest of all the months for the district.

As far as the tahasilwise monthly rainy days were considered, the highest number of rainy days were noted in Dharangaon (15 days) in July followed by Bodhwada and Muktainagar (14 days) in July. Bhusawal, Chopada, Erandol, Jalgaon and Yawal recorded 12 rainy days in July. Muktainagar, Pachora and Parola recorded 12 rainy days in August. 11 rainy days were observed in Amalner, Bhadagaon in July and Raver in August. Chalisgaon recorded 10 rainy days in August. This variation in monthly rainy days showed that Dhargaon tahasil that falls in the Satpura range had highest number of rainy days and it decreased in rest of the tahasils of scarcity zone.

It was observed that highest number of rainy days were recorded in the month of July which is useful for *Kharif* cropping as well as later vegetative growth stages of crops. Also, there are assured rainy days for cultivation of *Rabi* season crops in some tahasils.

All the tahasils of Jalgaon district have the lowest rainy days as 0, 1 or 2 in the month of January to May and also in November and December. So there is no assurance of summer cropping but can be done under irrigated condition.

Shaikh *et al.* (2018 c) reported similar finding on Satara district of Maharashtra state.

Table 4.6: Tahasilwise monthly rainy days (numbers) variation in Jalgaon district (1961-2016)

Month	Tahasil											
	Amalner			Bhadagaon			Bhodawada			Bhusawal		
	RD (Nos)	S. D.	C. V. (%)	RD (Nos)	S. D.	C. V. (%)	RD (Nos)	S. D.	C. V. (%)	RD (Nos)	S. D.	C. V. (%)
January	0	0.04	280.91	0	0.48	245.97	0	0.74	297.87	1	0.54	304.06
February	1	1.01	331.92	1	0.44	311.01	0	0.07	261.49	0	0.81	325.86
March	0	0.69	214.78	0	0.69	225.79	0	0.85	206.48	0	0.67	266.97
April	0	0.48	338.45	0	0.26	363.82	0	0.52	363.82	0	0.53	330.89
May	1	0.67	251.61	1	1.06	257.58	1	1.01	176.76	1	0.93	193.72
June	6	3.04	49.73	7	3.35	50.77	8	3.39	44.02	6	3.05	49.93
July	11	3.31	29.68	11	3.04	30.81	14	4.02	29.59	12	4.02	35.71
August	10	3.99	39.77	11	3.55	31.66	13	4.17	32.22	11	3.48	32.33
September	6	3.37	53.78	8	4.03	54.52	8	4.01	53.86	7	4.17	63.96
October	2	2.15	95.06	2	2.03	102.14	3	2.52	94.89	2	2.06	103.84
November	1	1.68	170.92	1	1.73	194.02	1	1.99	189.33	1	1.34	196.93
December	1	0.78	206.95	1	1.09	179.55	1	0.97	209.28	1	0.78	206.95
Total	40			43			49			42		
Highest	11	3.31	29.68	11	3.55	31.66	14	4.02	29.59	12	4.02	35.71
Month	July			August			July			July		
Lowest	0	0.04	280.91	0	0.26	363.82	0	0.52	363.82	0	0.53	330.89
Month	January			April			April			April		

Table 6 contd....

Table 4.6: Tahasilwise monthly rainy days (numbers) variation in Jalgaon district (1961-2016)

Month	Tahasil											
	Chalisgaon			Chopada			Dharangaon			Erاندول		
	RD (Nos)	S. D.	C. V. (%)	RD (Nos)	S. D.	C. V. (%)	RD (Nos)	S. D.	C. V. (%)	RD (Nos)	S. D.	C. V. (%)
January	1	0.65	241.33	0	0.42	259.33	0	0.61	244.21	1	0.49	230.59
February	0	0.05	308.88	1	0.62	218.47	0	0.69	225.79	0	0.43	343.25
March	0	0.86	230.59	0	0.67	266.97	1	0.73	178.48	0	0.77	307.48
April	0	0.13	748.33	0	0.41	384.97	0	0.57	246.31	0	0.19	524.32
May	1	1.04	182.35	1	1.01	209.25	1	1.26	207.58	0	0.91	196.82
June	7	3.24	45.09	6	3.32	52.03	9	3.58	39.97	6	2.52	39.52
July	10	3.38	34.49	12	4.09	32.95	15	4.25	27.83	12	4.03	36.65
August	10	3.46	33.42	11	3.59	32.48	13	4.04	30.04	11	3.06	31.74
September	9	4.26	45.03	7	3.79	54.21	9	4.28	49.05	6	3.98	61.36
October	3	2.62	94.04	2	2.03	94.14	3	2.74	85.03	2	2.07	98.84
November	1	1.75	185.13	1	1.57	187.05	1	2.08	157.49	1	1.61	205.53
December	0	0.87	211.63	1	0.95	241.13	1	1.16	223.96	1	1.03	205.38
Total	43			43			54			42		
Highest	10	3.46	33.42	12	4.09	32.95	15	4.25	27.83	12	4.03	36.65
Month	August			July			July			July		
Lowest	0	0.13	748.33	0	0.41	384.97	0	0.57	246.31	0	0.19	524.32
Month	April			April			April			April		

Table 6 contd

Table 4.6: Tahasilwise monthly rainy days (numbers) variation in Jalgaon district (1961-2016)

Month	Tahasil											
	Jalgaon			Jamner			Muktainagar			Pachora		
	RD (Nos)	S. D.	C. V. (%)	RD (Nos)	S. D.	C. V. (%)	RD (Nos)	S. D.	C. V. (%)	RD (Nos)	S. D.	C. V. (%)
January	1	0.56	197.02	1	0.58	322.26	1	0.64	255.84	0	0.44	226.00
February	0	0.77	289.01	0	0.52	264.44	0	0.73	271.01	1	0.04	280.91
March	1	1.17	192.79	0	0.85	215.33	0	0.87	195.37	0	0.08	213.11
April	0	0.41	384.97	0	0.03	553.07	0	0.52	363.82	0	0.32	451.26
May	1	0.93	152.83	0	0.97	217.47	1	1.03	156.16	0	0.81	252.45
June	7	3.03	45.43	6	2.96	45.67	8	3.55	43.36	6	3.01	48.31
July	12	3.75	30.67	11	3.79	32.97	14	4.63	32.45	11	4.00	36.08
August	11	4.47	40.15	12	3.77	32.58	14	3.78	27.85	12	3.75	31.82
September	7	3.32	47.25	7	3.76	55.05	9	4.56	51.66	8	4.06	52.94
October	2	2.18	96.05	2	2.37	107.89	3	2.58	90.39	2	2.01	95.21
November	1	1.68	181.02	1	1.75	188.06	1	2.06	186.05	1	1.93	174.53
December	1	1.01	201.81	1	0.82	229.21	1	0.99	198.17	1	1.02	179.27
Total	44			43			52			43		
Highest	12	3.75	30.67	12	3.77	32.58	14	4.63	32.45	12	3.75	31.82
Month	July			August			July			August		
Lowest	0	0.41	384.97	0	0.03	553.7	0	0.52	363.82	0	0.32	451.26
Month	April			April			April			April		

Table 6 contd

Table 4.6: Tahasilwise monthly rainy days (numbers) variation in Jalgaon district (1961-2016)

Month	Tahasil											
	Parola			Raver			Yawal			District Average		
	RD (Nos)	S. D.	C. V. (%)	RD (Nos)	S. D.	C. V. (%)	RD (Nos)	S. D.	C. V. (%)	RD (Nos)	S. D.	C. V. (%)
January	1	0.64	255.84	1	0.46	285.18	1	0.43	241.33	1	0.54	259.02
February	0	0.52	264.44	0	0.77	289.10	0	0.56	262.07	0	0.63	283.02
March	0	0.67	251.61	0	0.72	202.82	0	0.82	219.09	0	0.79	225.08
April	0	0.46	285.18	0	0.39	441.68	0	0.47	263.09	0	0.40	403.00
May	0	0.77	238.01	1	0.72	212.37	1	1.09	277.48	1	0.95	212.20
June	7	3.09	45.75	7	3.05	53.11	6	3.13	49.82	7	3.19	46.08
July	12	3.69	30.32	10	3.91	37.98	12	3.85	31.03	12	3.92	32.0
August	11	3.67	33.17	11	4.00	36.28	10	3.40	33.14	11	3.78	33.03
September	7	3.66	49.86	7	3.71	49.73	7	3.70	50.51	7	3.92	52.09
October	3	2.69	104.58	3	2.03	85.14	2	2.18	94.72	2	2.32	96.02
November	2	1.85	172.43	1	1.52	188.98	1	1.21	194.32	1	1.72	184.8
December	0	1.29	278.46	0	0.93	193.72	1	0.95	197.72	1	0.98	210.09
Total	44			42			43			44		
Highest	12	3.69	30.32	11	4.00	36.28	12	3.85	31.03	12	3.92	32.02
Month	August			August			July			July		
Lowest	0	0.77	238.01	0	0.39	441.68	0	0.47	263.09	0	0.41	396.01
Month	May			April			April			April		

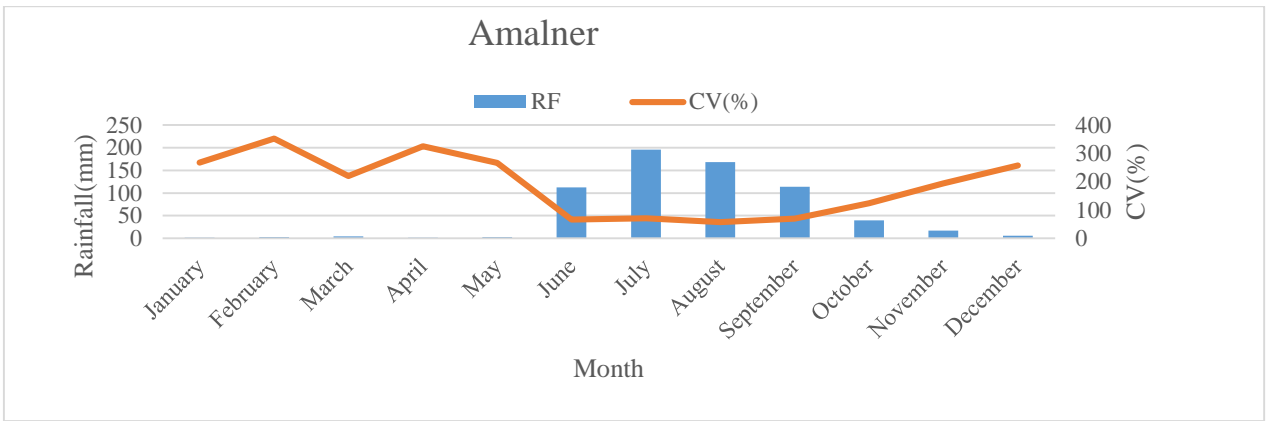


Fig 22: Monthly rainfall of Amalner tahasil (1961-2016)

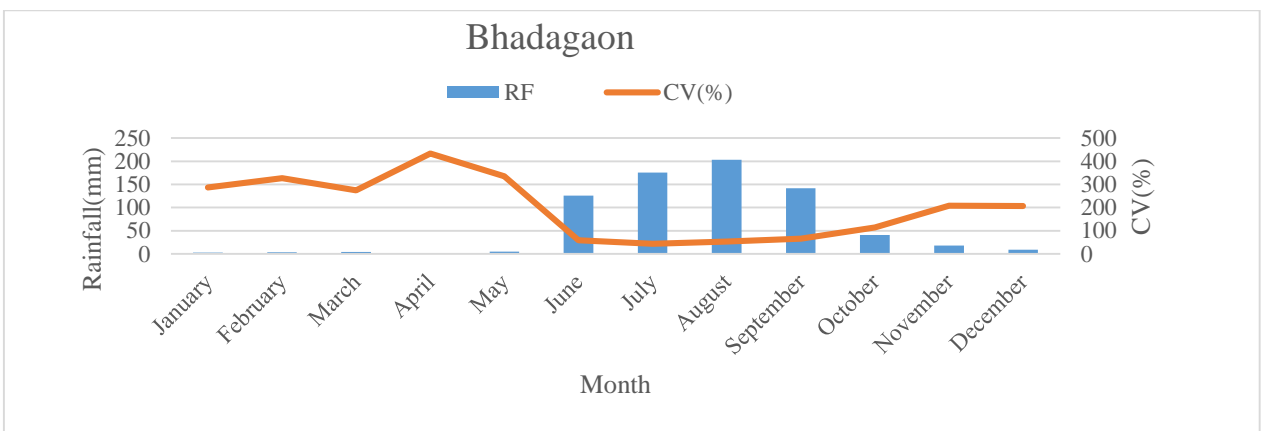


Fig 23: Monthly rainfall of Bhadagaon tahasil (1961-2016)

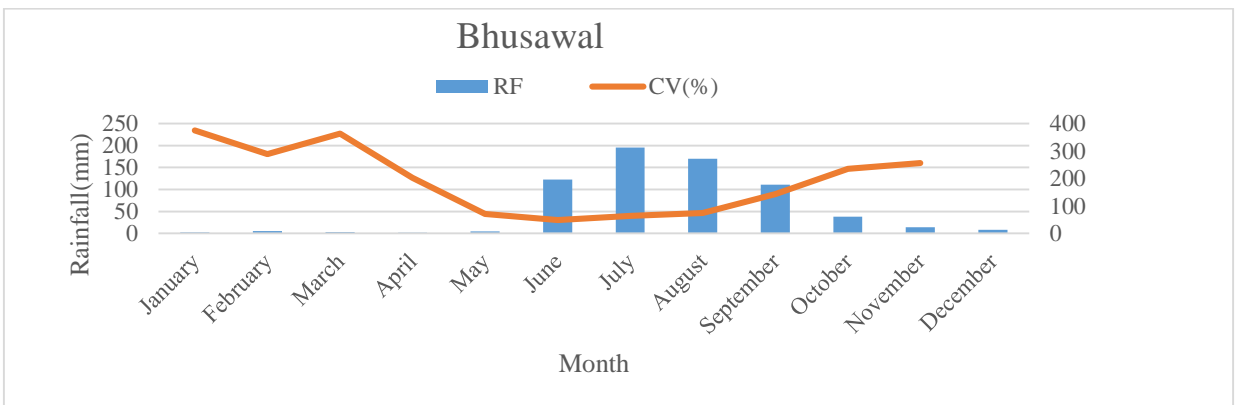


Fig 24: Monthly rainfall of Bhusawal tahasil (1961-2016)

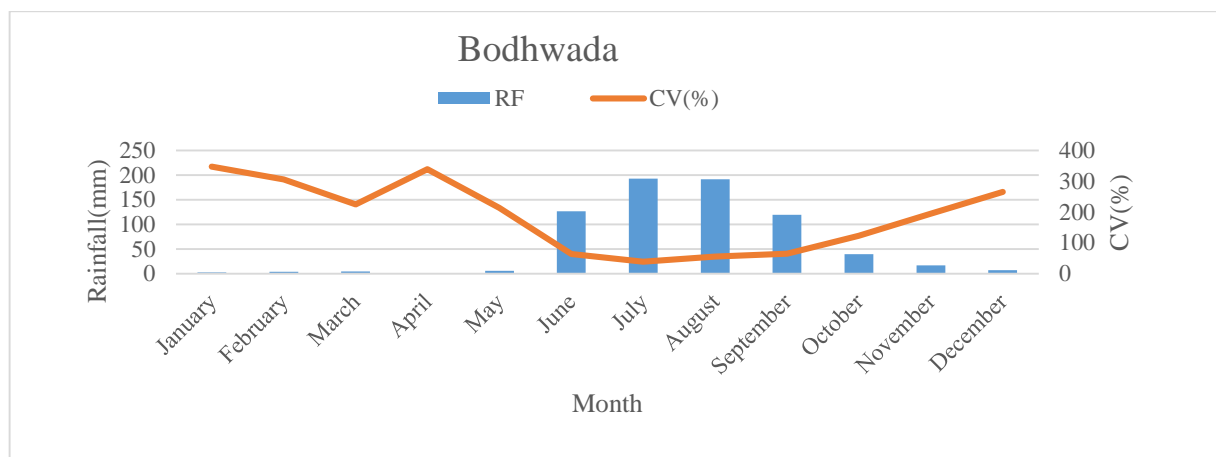


Fig 25: Monthly rainfall of Bodhwada tahasil (1961-2016)

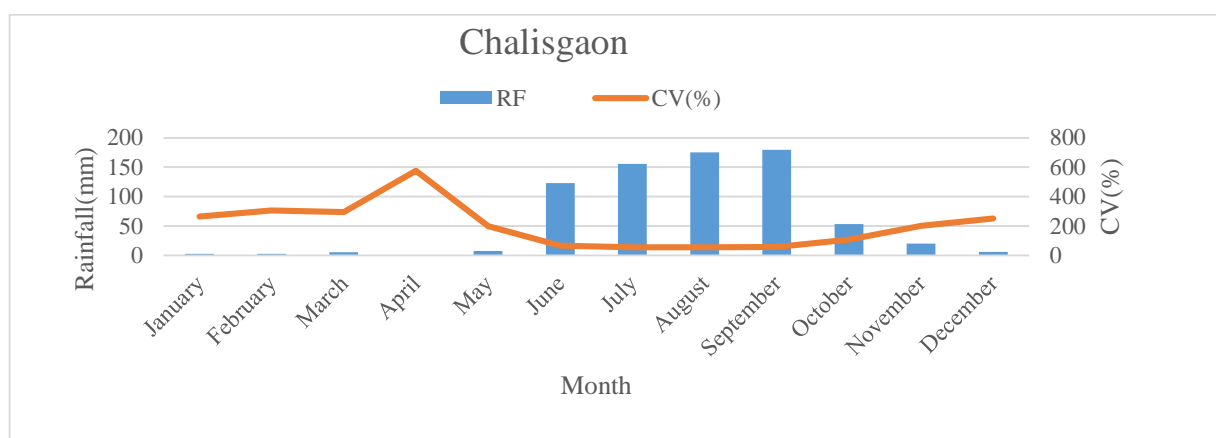


Fig 26: Monthly rainfall of Chalisgaon tahasil (1961-2016)

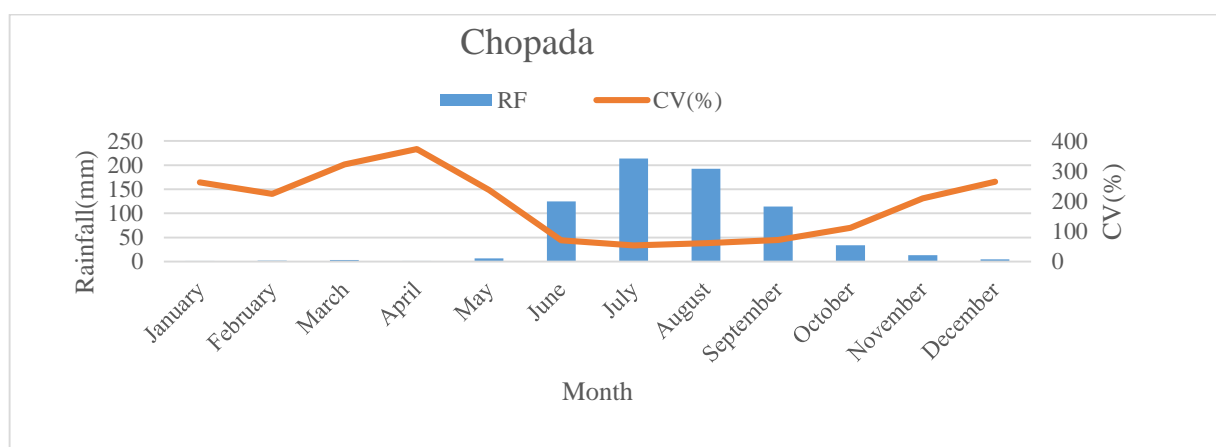


Fig 27: Monthly rainfall of Chopada tahasil (1961-2016)

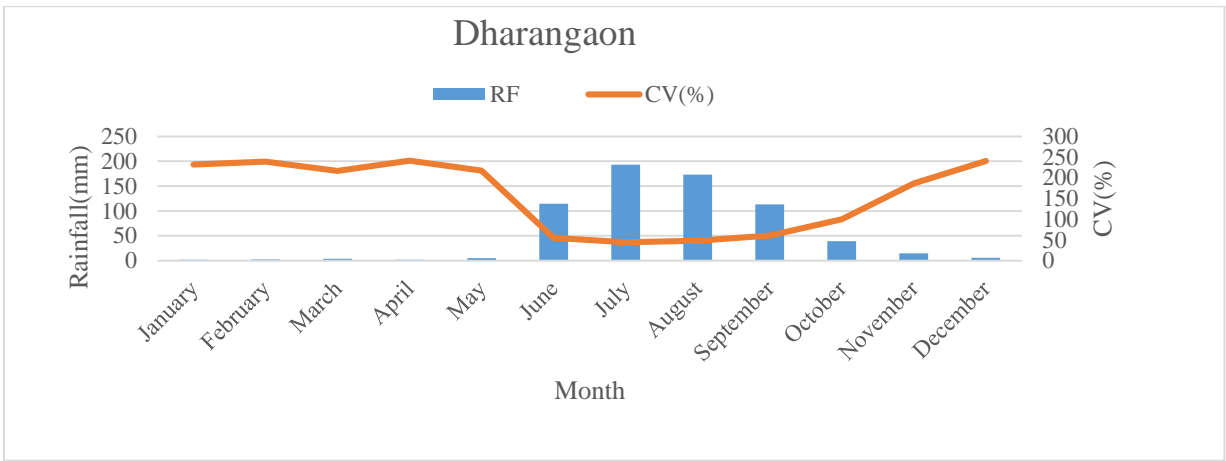


Fig 28: Monthly rainfall of Dharangaon tahasil (1961-2016)

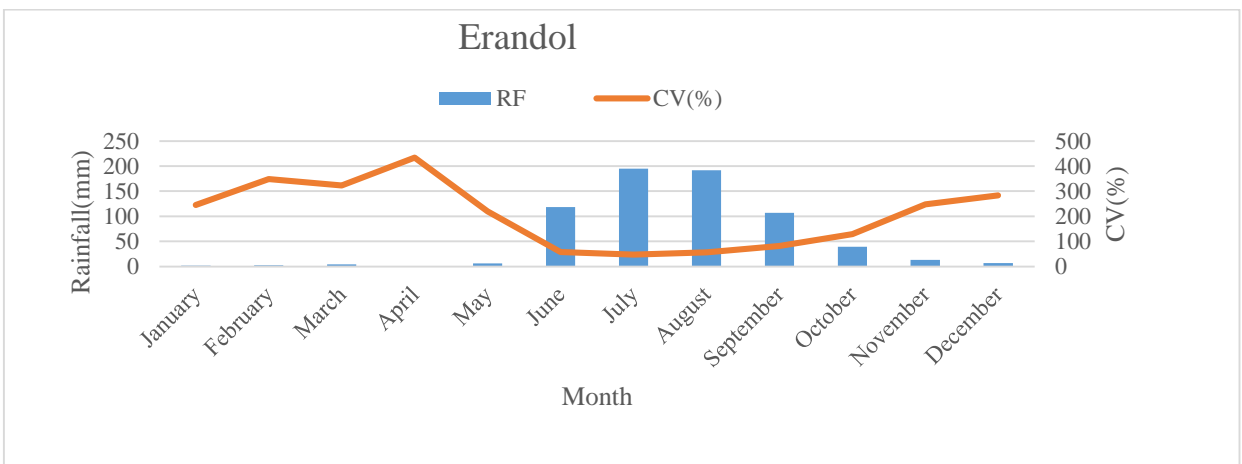


Fig 29: Monthly rainfall of Erandol tahasil (1961-2016)

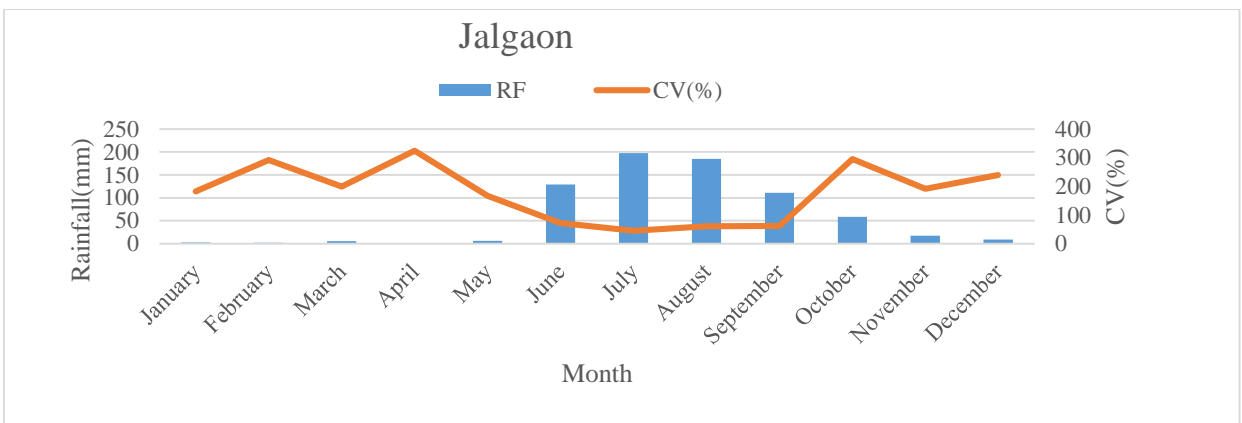


Fig 30: Monthly rainfall of Jalgaon tahasil (1961-2016)

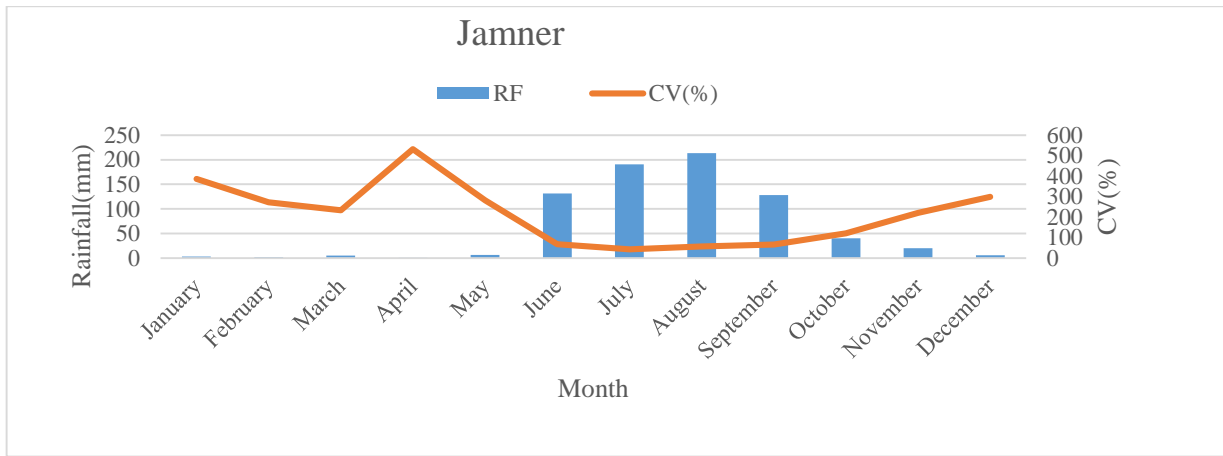


Fig 31: Monthly rainfall of Jamner tahasil (1961-2016)

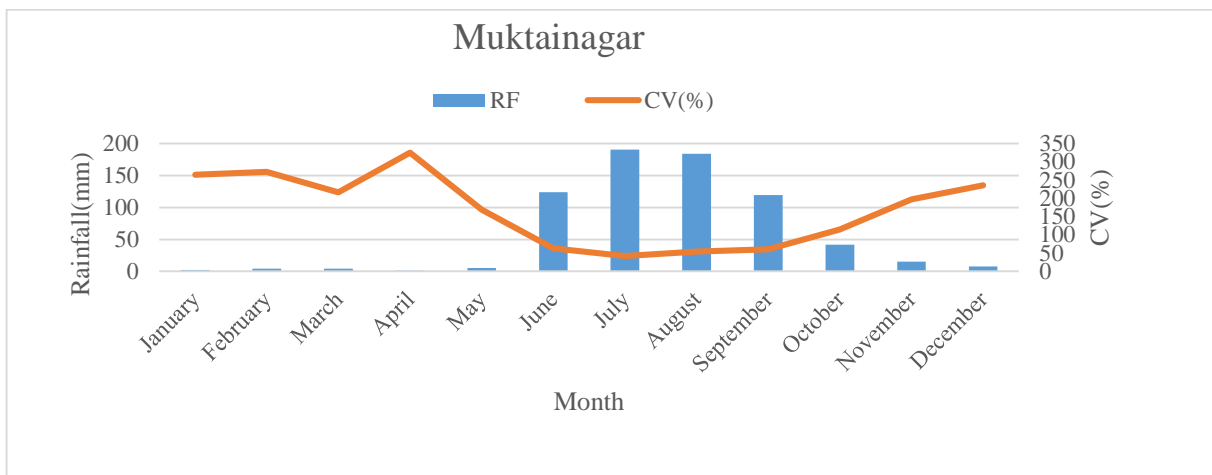


Fig 32: Monthly rainfall of Muktainagar tahasil (1961-2016)

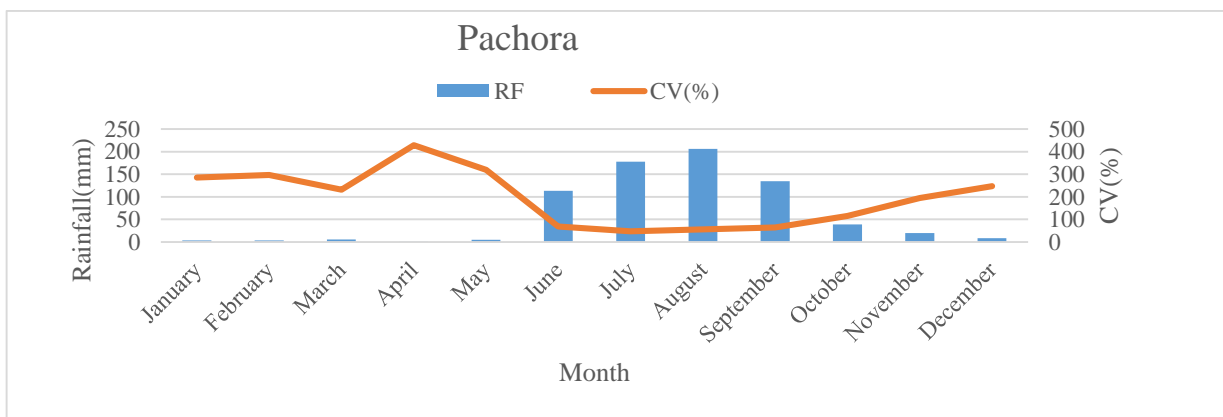


Fig 33: Monthly rainfall of Pachora tahasil (1961-2016)

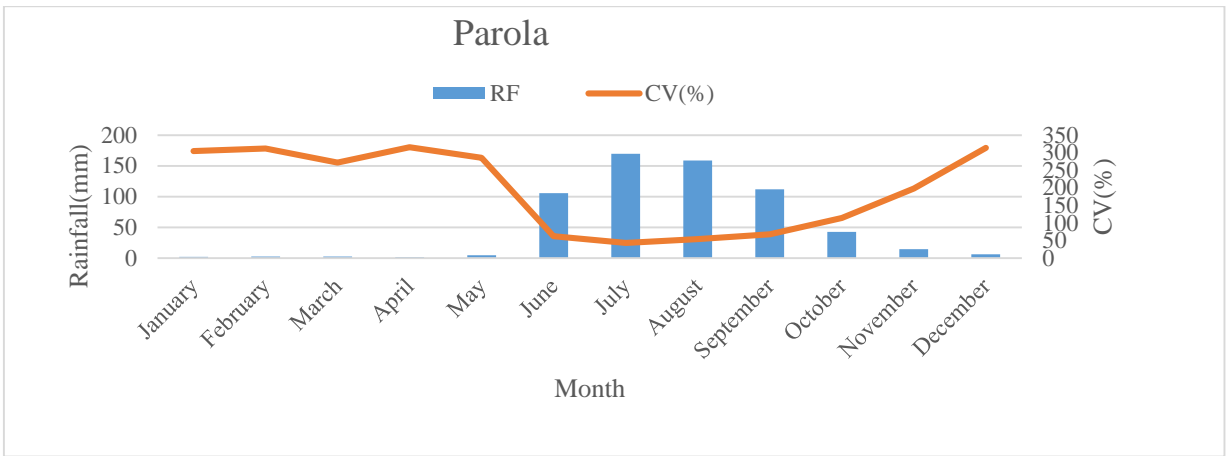


Fig 34: Monthly rainfall of Parola tahasil (1961-2016)

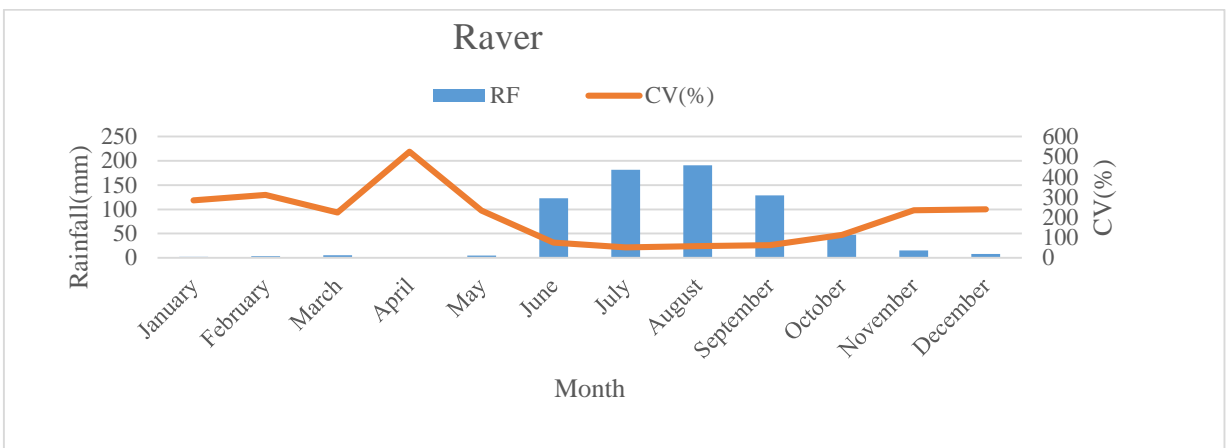


Fig 35: Monthly rainfall of Raver tahasil (1961-2016)

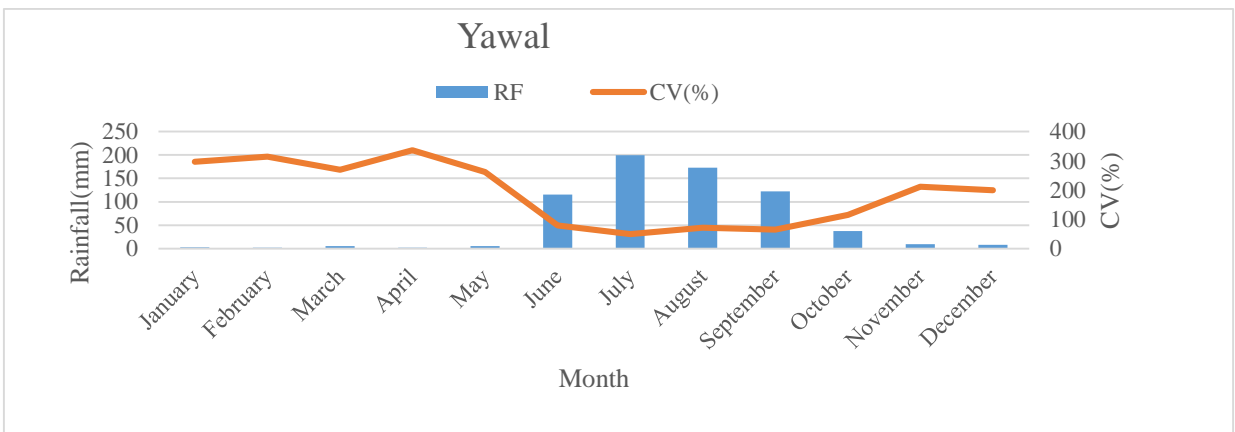


Fig 36: Monthly rainfall of Yawal tahasil (1961-2016)

4.7. Weekly Rainfall Variability

The annual as well as seasonal and monthly rainfall variation within tahasils is discussed earlier at length. The availability of water for crops in a season depends on the distribution and variability of weekly rainfall. Hence, from crop management point of view, week is to be considered as the ideal period for crop planning, scheduling farm operations and land use operations and therefore the weekly rainfall analysis of each tahasil was worked out and presented in Table 7 and depicted in figures from 6.1 to 6.15.

The data on mean weekly rainfall in each tahasil are presented in Table 7. The data indicated that weekly rains played significant role from *in-situ* management point of view. Hence, the rainfall concentrated from 23rd to 41th MW. The average of weekly rainfall of Jalgaon district was 698.87 mm starting from 21 MW, whereas, ending at 50 MW. However, it decreased slowly from 37 MW. Rainfall showed a sharp decrease from 42 MW. The variation of highest weekly rainfall (53.1 mm) was 114.2 per cent for Jalgaon district.

Besides this the tahasilwise variation in weekly rainfall was also observed. The total highest weekly rainfall was 748.3 mm in Jamner starting from 22 MW and ends in 48 MW followed by Chalisgaon (731.6 mm from 21 to 46 MW), Bhadagaon (729.3 mm from 22 to 48 MW), Jalgaon (723.4 mm from 22 to 46 MW), Pachora (716.4 mm from 22 to 47 MW), Bodhwada (711.7 mm from 22 to 47 MW), Chopada (711.5 mm from 22 to 47 MW), Raver (711.1 mm from 22 to 48 MW), Muktainagar (699.9 mm from 22 to 44 MW), Erandol (685.0 mm from 22 to 47 MW), Yawal (681.9 mm from 22 to 42 MW), Bhusawal (675.1 mm from 22 to 44 MW), Dharangaon (667.3 mm from 22 to 47 MW), Amalner (667.2 mm from 22 to 47 MW) and Parola (623.1 mm from 22 to 47 MW). Within these weeks Chalisgaon (54.2 mm with 124.53 per cent variation) observed the highest rainfall in 36 MW. Bodhwada (58.7 mm with 128.25 per cent variation), Bhusawal (53.6 mm with 152.59 per cent variation), Chopada (61.6 mm with 131.29 per cent variation), Dharangaon (49.9 mm with 102.81 per cent variation), Erandol (53.4 mm with 100.59 per cent variation), Jalgaon (58.6 mm with 121.98 per cent variation), Jamner (63.8 mm with 115.45 per cent variation), Muktainagar (57.1 mm with 137.71 per cent variation), Pachora (53.1 mm with 124.32 per cent variation), Raver (58.6 mm with 141.91 per cent variation), and Yawal (58.1 mm with 158.87 per cent variation) observed the highest rainfall in 32 MW. 31th MW recorded highest rainfall for Amalner (61.0 mm with 220.86 per cent variation) and Bhadagaon (54.4 mm with 102.21 per cent variation) and Parola (42.2 mm with 84.09 per cent variation) recorded highest rainfall in 30 MW which showed the good yield of *kharif* cropping and for *rabi* season also.

For rest of all the meteorological weeks, the rainfall contribution was very meager as compared to other meteorological weeks. But this rainfall can be good for preparatory tillage in summer season for all the tahasils.

Similar study was carried out by Sahane and Jadhav (1998), Jadhav *et al.* (1999) and Shaikh *et al.* (2017 f) for Vadgaon Maval, scarcity zone of Maharashtra and Satara district respectively.

Table 4.7. Tahasilwise weekly rainfall (mm) variation in Jalgaon district (1961-2016)

MW	Tahasil											
	Amalner			Bhadagaon			Bhodwada			Bhusawal		
	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)
01	0.3	1.47	446.76	0.5	2.44	492.04	1.0	1.00	425.84	1.94	1.94	405.02
02	0.6	2.06	459.32	1.2	4.87	406.02	0.6	0.60	519.40	5.72	5.72	614.82
03	0.2	1.26	527.28	1.1	5.26	497.08	1.3	1.30	503.18	3.27	3.27	404.69
04	0.2	1.64	748.33	0.3	2.00	748.33	0.0	0.00	748.36	0.00	0.00	0.00
05	1.3	5.58	446.14	1.1	8.02	748.33	0.3	0.03	748.33	0.00	0.00	0.00
06	0.4	1.71	444.24	0.4	2.15	506.07	0.9	0.09	591.54	9.09	9.09	606.19
07	0.3	1.37	468.77	0.5	4.08	748.33	0.5	0.05	582.16	3.62	3.62	704.59
08	0.9	3.37	398.62	1.4	6.08	441.96	1.8	1.08	369.84	12.12	12.12	401.96
09	1.1	5.02	462.07	0.0	0.00	0.00	0.9	0.09	412.78	2.07	2.07	608.66
10	1.1	4.51	412.93	0.4	2.49	568.75	0.7	0.07	310.41	2.90	2.09	476.86
11	0.8	3.49	422.07	1.2	4.91	396.51	1.7	1.07	392.16	5.97	5.97	374.52
12	0.6	3.62	582.01	0.8	4.44	525.98	0.6	0.06	570.07	3.85	3.85	748.33
13	1.2	4.92	397.24	1.5	8.55	564.04	0.7	0.07	517.51	1.01	1.01	566.15
14	0.2	1.22	561.64	0.1	0.04	748.33	0.2	0.02	596.47	1.88	1.88	722.69
15	1.2	5.19	449.99	0.1	0.67	748.33	0.3	0.03	438.17	2.67	2.67	518.0
16	0.0	0.00	0.00	0.2	1.08	748.33	0.3	0.03	459.00	2.29	2.29	451.61
17	0.2	1.34	748.33	0.3	2.41	748.33	0.1	0.01	748.33	1.34	1.34	748.33
18	0.5	2.47	460.19	0.7	4.57	662.37	0.3	0.03	469.72	1.44	1.44	532.94
19	1.2	4.91	426.92	1.1	4.06	408.59	1.0	1.00	331.89	5.35	5.35	390.45
20	0.2	0.68	371.18	1.0	3.31	333.15	0.8	0.08	368.03	2.02	2.02	386.68
21	0.6	3.52	606.04	1.4	8.22	587.28	2.3	2.03	276.62	6.23	6.23	327.26
22	4.2	10.81	259.26	5.6	16.26	290.85	4.2	4.02	261.75	9.08	9.08	318.81
23	15.8	34.22	216.92	19.9	37.34	187.68	18.5	18.05	188.95	36.07	36.07	203.98
24	24.4	24.87	101.85	32.5	33.99	104.51	34.7	34.07	129.73	47.02	47.02	144.69
25	34.5	41.35	119.84	32.7	38.39	117.47	29.1	29.01	125.60	37.09	37.09	131.04
26	38.5	41.03	106.65	40.2	40.31	100.02	46.4	46.04	117.88	61.77	61.77	133.97
27	43.3	53.56	123.06	36.7	36.28	98.93	40.6	40.06	86.27	41.75	41.75	109.04

Table 7 contd...

MW	Tahasil											
	Amalner			Bhadagaon			Bhodwada			Bhusawal		
	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)
28	37.6	34.97	92.94	34.0	29.58	86.92	45.4	39.85	87.76	50.23	50.23	101.19
29	37.6	28.06	76.03	35.7	31.46	88.26	43.2	32.92	76.15	41.54	41.54	90.11
30	43.3	39.05	90.25	47.4	46.05	98.13	46.6	38.08	81.65	37.64	37.64	84.07
31	61.0	134.73	220.86	54.4	55.57	102.21	45.0	38.74	86.02	34.85	34.85	89.33
32	47.9	49.02	102.37	43.0	47.13	109.48	58.7	75.26	128.25	81.08	81.08	152.59
33	31.8	38.42	120.78	39.6	52.39	132.28	39.7	45.34	114.35	48.11	48.11	135.01
34	30.8	35.51	115.39	48.0	46.62	97.22	36.6	36.71	100.21	34.85	34.85	112.41
35	39.4	50.66	128.64	50.9	55.19	108.47	37.7	34.74	92.28	36.05	36.05	111.08
36	35.9	45.37	126.38	42.5	50.05	117.72	33.5	39.98	119.24	40.15	40.15	127.01
37	25.1	37.74	150.35	26.9	34.51	128.52	23.2	34.96	151.04	41.45	41.45	161.65
38	18.7	24.47	131.11	32.3	44.95	139.02	31.8	38.51	121.02	38.38	38.38	141.37
39	21.5	36.96	172.02	24.2	39.02	161.05	17.4	26.59	152.78	27.53	27.53	176.68
40	14.6	23.13	158.6	15.1	27.44	182.08	16.0	27.74	173.09	32.22	32.22	196.13
41	15.6	39.32	252.43	12.2	30.33	247.74	12.7	36.16	285.14	42.51	42.51	330.27
42	3.2	8.63	269.88	6.2	17.81	285.82	4.4	11.24	253.73	8.02	8.02	272.88
43	4.1	10.92	266.85	6.7	20.18	301.41	4.3	15.22	358.27	18.54	18.54	395.79
44	3.1	14.37	464.97	1.5	5.37	368.01	4.8	16.07	337.07	21.5	21.05	405.29
45	1.9	5.56	290.45	2.8	9.84	355.38	2.8	8.87	318.72	8.88	8.88	344.31
46	5.6	16.65	297.74	5.6	18.47	327.62	4.2	16.41	390.83	17.57	17.57	545.44
47	5.6	19.05	338.64	5.2	14.03	275.23	4.1	11.55	282.67	8.71	8.71	325.09
48	3.7	14.35	393.43	4.2	16.09	380.91	3.4	14.09	420.03	7.23	7.23	514.92
49	2.5	8.86	354.84	3.9	13.09	361.16	3.9	16.55	425.64	16.37	16.37	422.09
50	2.5	12.31	496.55	2.7	10.63	388.15	1.6	7.91	504.01	12.02	12.02	541.35
51	0.4	2.00	456.06	0.9	3.53	385.11	0.7	2.54	377.35	4.34	4.34	463.29
52	0.2	1.19	582.13	0.8	5.91	748.33	0.7	4.82	705.16	5.43	5.43	675.79
Total	667.2			729.58			711.7			675.13		
Max	61.0	134.73	220.86	54.7	55.57	102.21	58.7	75.26	128.25	53.6	81.8	152.59
MW	31			31			32			32		

Table 7 contd...

Table 4.7. Tahasilwise weekly rainfall (mm) variation in Jalgaon district (1961-2016)

MW	Tahasil											
	Chalisgaon			Chopada			Dharangaon			Erandol		
	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)
01	0.6	3.22	501.15	0.6	2.52	421.22	0.4	1.77	419.28	0.3	1.62	648.35
02	1.2	5.45	466.01	0.5	2.61	561.06	0.7	3.24	448.64	0.5	2.35	475.91
03	0.5	3.13	626.68	0.4	1.94	445.49	0.3	1.13	382.21	0.4	1.70	447.56
04	0.1	0.48	748.33	0.0	0.23	748.33	0.3	0.96	341.37	0.4	1.55	424.39
05	0.9	3.88	425.67	0.2	1.74	748.33	0.6	2.20	366.07	0.2	1.61	668.86
06	0.2	1.49	641.52	0.3	1.42	480.41	0.3	1.07	396.72	0.6	4.28	718.97
07	0.4	2.67	748.33	0.2	0.83	541.82	0.5	2.58	564.34	0.7	4.56	635.00
08	1.3	6.95	526.01	1.1	3.39	304.35	1.1	3.34	318.75	0.9	3.03	366.9
09	0.9	5.65	608.11	0.9	3.83	408.99	0.7	2.62	359.58	0.2	1.66	748.33
10	1.2	3.52	285.02	0.5	3.36	671.05	0.6	1.99	311.63	0.3	2.15	748.33
11	0.8	3.57	448.91	1.4	6.11	446.59	1.2	4.00	337.16	2.4	10.00	419.11
12	1.0	4.33	438.71	0.6	4.38	748.33	0.5	3.63	682.95	0.7	4.68	666.61
13	1.6	10.35	633.00	0.4	1.09	504.04	0.7	2.06	313.83	0.3	1.59	494.93
14	0.0	0.27	748.33	0.4	3.21	748.33	0.5	2.51	482.71	0.0	0.00	0.00
15	0.0	0.00	0.00	0.3	2.27	748.33	0.5	2.31	427.64	0.2	1.78	748.33
16	0.0	0.13	748.33	0.3	2.07	748.33	0.1	0.71	614.44	0.1	1.07	748.33
17	0.2	1.02	748.33	0.0	0.00	0.00	0.2	0.83	538.82	0.1	0.56	524.32
18	1.4	6.89	482.37	0.1	0.63	513.29	0.3	0.90	344.99	0.1	0.66	529.84
19	1.1	4.43	420.37	3.7	12.62	343.12	2.4	8.33	342.69	1.8	8.00	455.67
20	0.4	2.18	517.16	0.5	1.98	385.18	0.4	1.27	321.06	1.2	4.26	358.50
21	3.7	11.05	296.95	1.6	6.01	390.21	1.0	3.68	383.96	1.1	3.74	335.47
22	7.0	16.67	237.21	4.1	11.99	290.27	4.3	7.86	184.87	5.6	16.57	293.73
23	27.7	52.04	188.04	16.7	39.17	234.14	16.8	30.37	180.95	15.4	27.54	178.46
24	30.9	29.86	96.79	31.1	44.72	143.88	27.2	27.57	101.37	30.2	37.53	124.39
25	30.6	39.26	128.13	32.4	50.28	155.41	31.1	34.31	110.45	31.6	40.26	127.59
26	32.1	36.28	113.02	46.5	54.74	117.72	40.8	38.81	95.20	40.9	43.85	107.16
27	41.2	43.15	104.66	48.1	69.86	145.16	42.3	48.93	115.64	45.5	47.26	103.93

Table 7 contd...

MW	Tahasil											
	Chalisgaon			Chopada			Dharamgaon			Erandol		
	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)
28	31.8	38.42	121.00	43.9	45.52	103.59	39.2	32.73	83.58	41.2	39.92	96.86
29	30.6	29.11	95.29	48.6	42.89	88.23	40.9	26.29	64.33	43.8	36.14	82.49
30	39.0	43.03	110.46	55.5	49.07	88.45	47.0	34.75	73.97	49.1	40.22	81.89
31	32.8	39.82	121.28	44.4	45.59	102.79	48.2	64.73	134.34	36.0	34.40	95.50
32	42.5	54.78	128.95	61.6	80.82	131.29	49.9	51.30	102.81	53.4	53.72	100.59
33	32.4	39.39	121.50	33.5	37.68	112.65	32.5	29.92	92.14	41.2	51.09	124.06
34	45.4	50.78	111.85	39.8	55.21	138.75	33.3	39.79	119.41	38.7	48.61	125.54
35	44.7	42.90	95.96	36.9	42.80	116.10	39.3	39.74	101.2	45.2	47.11	104.24
36	54.2	67.51	124.53	40.9	59.79	146.32	38.2	46.73	122.23	32.3	46.75	144.64
37	38.0	44.99	118.31	23.5	32.24	137.40	23.9	29.82	124.84	19.3	26.03	135.11
38	40.4	43.87	108.61	20.6	35.37	171.43	20.1	25.58	127.15	24.7	32.12	130.16
39	33.6	47.21	140.60	17.7	27.89	157.55	19.8	25.73	129.74	19.4	38.60	198.70
40	26.4	35.28	133.47	14.5	23.56	161.97	16.2	20.54	126.84	17.9	25.83	144.30
41	12.7	34.37	271.54	11.1	27.11	243.31	13.1	29.20	223.27	13.5	41.62	307.39
42	5.6	14.27	255.21	5.0	12.69	253.17	4.2	12.76	306.27	4.0	12.36	307.84
43	4.5	15.14	340.03	2.4	9.25	381.83	4.1	11.73	288.62	3.0	9.02	300.21
44	5.4	17.20	320.48	1.0	3.80	396.24	2.0	6.31	324.32	0.6	1.94	314.81
45	4.5	13.51	300.70	1.4	3.58	264.57	1.9	5.07	272.15	1.5	5.87	384.86
46	8.7	24.02	276.71	6.1	20.31	334.83	5.0	15.66	311.07	4.2	18.97	455.20
47	2.8	11.70	416.64	4.7	14.58	313.78	5.0	14.31	283.70	4.2	11.76	279.21
48	3.3	19.11	588.07	1.2	5.71	494.21	2.6	8.13	307.81	3.3	14.66	449.03
49	1.7	9.27	546.53	1.8	7.37	412.58	2.4	9.49	400.96	2.9	14.89	519.37
50	2.0	8.94	459.17	2.0	10.30	516.32	2.0	8.19	409.44	2.5	12.17	487.04
51	0.9	5.67	648.35	0.4	1.81	503.17	0.7	2.72	395.12	0.7	3.32	466.59
52	1.0	6.82	707.22	0.5	1.94	424.64	0.4	1.78	472.22	0.6	2.85	466.68
Total	731.6			711.5			667.3			685.0		
Max	54.2	67.51	124.53	61.6	80.82	131.29	49.9	51.3	102.81	53.4	53.72	100.59
MW	36			32			32			32		

Table 7 contd...

Table 4.7. Tahasilwise weekly rainfall (mm) variation in Jalgaon district (1961-2016)

MW	Tahasil											
	Jalgaon			Jamner			Muktainagar			Pachora		
	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)
01	0.7	2.89	442.82	1.4	6.93	481.83	0.6	2.53	416.30	0.6	2.82	463.65
02	0.3	0.91	322.59	0.3	1.99	748.33	0.7	3.14	451.52	1.9	8.40	453.13
03	0.7	2.37	337.85	1.7	9.97	591.27	0.9	3.56	406.59	0.7	2.75	393.68
04	0.7	2.49	351.70	0.0	0.20	748.33	0.2	1.03	526.56	0.2	1.20	748.33
05	0.3	1.02	387.52	0.5	3.74	748.33	0.3	1.62	503.78	0.8	5.37	668.86
06	0.5	3.66	742.83	0.2	0.89	520.05	1.0	5.30	549.45	0.1	0.80	712.94
07	0.6	2.80	461.90	0.5	2.54	503.70	0.8	3.77	468.89	0.6	4.19	686.84
08	0.7	2.96	445.20	0.7	2.63	405.12	1.9	6.78	361.45	1.9	7.96	413.31
09	0.6	2.42	415.34	1.4	5.67	406.64	0.6	2.20	342.64	0.9	4.01	432.17
10	0.8	3.52	438.07	0.8	3.39	402.16	0.7	2.23	320.40	0.9	5.01	537.41
11	1.6	5.71	351.90	1.7	7.57	439.86	1.8	6.22	341.52	1.4	6.46	453.77
12	1.0	3.75	370.36	0.7	3.10	472.28	0.7	3.78	571.63	0.7	4.06	547.68
13	1.5	5.57	368.11	1.2	6.93	592.86	0.7	3.39	498.85	1.5	8.21	537.98
14	0.3	1.35	548.27	0.1	0.51	748.33	0.2	1.21	676.29	0.0	0.33	748.33
15	0.2	1.25	575.65	0.1	0.94	748.33	0.3	1.66	517.56	0.3	2.14	748.33
16	0.7	3.84	524.07	0.1	0.79	748.33	0.5	1.94	388.94	0.2	1.43	748.33
17	0.1	0.52	444.12	0.0	0.00	0.00	0.1	0.67	748.33	0.2	1.34	726.47
18	0.8	3.82	498.55	0.3	2.43	748.33	0.3	1.42	440.41	1.5	10.69	712.94
19	1.3	4.33	327.6	0.6	2.44	410.75	1.0	3.46	346.41	1.7	5.66	326.48
20	1.0	5.04	516.32	1.0	5.13	530.96	1.0	2.59	273.62	0.5	2.14	447.46
21	1.5	5.35	357.52	2.8	9.00	326.01	2.1	6.09	296.48	0.5	2.02	402.86
22	4.5	10.70	239.88	5.6	14.36	258.49	3.1	8.93	284.23	3.3	7.67	234.10
23	22.9	38.68	169.11	19.1	39.3	206.17	20.0	33.88	169.26	17.5	30.56	174.47
24	30.5	43.87	143.81	36.7	51.69	140.98	33.1	44.56	134.75	30.8	31.86	103.55
25	29.3	49.00	167.50	29.3	41.25	140.78	29.3	32.39	110.68	25.2	34.36	136.28
26	47.9	57.93	120.94	46.7	54.49	116.68	44.9	52.34	116.63	40.8	43.46	106.57
27	47.6	49.97	104.93	42.9	41.26	96.26	41.3	37.10	89.94	39.7	35.28	88.84

Table 7 contd...

MW	Tahasil											
	Jalgaon			Jamner			Muktainagar			Pachora		
	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)
28	48.6	54.00	111.13	41.2	35.64	86.54	43.3	37.94	87.62	36.7	36.51	99.50
29	40.8	36.38	89.12	40.4	32.59	80.76	41.8	32.49	77.81	36.6	31.77	86.72
30	44.6	40.35	90.40	48.5	49.04	101.14	46.7	35.68	76.36	47.5	42.44	89.32
31	43.2	35.36	81.80	51.1	50.02	97.94	41.5	33.69	81.18	51.7	55.79	108.00
32	55.2	67.32	121.98	63.8	73.61	115.45	57.1	78.59	137.71	53.1	66.05	124.32
33	36.1	42.35	117.41	43.7	52.42	120.06	38.1	38.32	100.57	36.1	39.80	110.34
34	36.1	40.73	112.85	42.3	41.77	98.79	34.3	34.70	101.25	48.0	46.19	96.18
35	33.8	36.12	106.79	42.8	39.14	91.36	38.1	34.70	91.03	47.1	49.45	104.9
36	36.2	44.16	121.99	35.4	43.79	123.57	35.2	37.35	106.13	39.0	45.92	117.88
37	22.0	29.38	133.57	20.7	32.93	159.44	24.5	32.93	134.30	23.8	28.52	119.84
38	27.5	34.22	124.63	36.5	45.89	125.75	29.0	33.59	115.82	34.6	42.41	122.57
39	16.4	36.15	220.36	19.2	29.70	154.51	17.8	24.43	137.08	21.5	31.87	148.18
40	16.9	27.11	160.44	15.5	26.30	170.03	16.6	26.50	159.40	13.4	19.68	146.64
41	32.5	163.06	502.36	12.5	33.45	267.77	14.3	37.91	265.37	10.5	28.89	275.76
42	4.6	15.21	334.55	5.9	16.31	275.20	4.1	9.34	226.48	7.2	22.89	319.71
43	2.9	7.24	247.21	3.8	12.95	339.95	4.6	14.57	316.24	6.6	21.09	317.94
44	3.5	10.80	308.67	4.2	15.18	360.22	4.4	14.33	328.81	1.9	5.89	304.39
45	3.7	8.47	230.61	3.0	9.40	314.48	2.9	8.69	296.6	3.5	10.80	307.14
46	6.2	22.26	356.91	5.2	16.29	314.49	3.2	15.05	465.64	6.2	20.53	331.09
47	2.6	10.82	413.19	5.5	16.96	308.59	3.8	11.36	298.56	5.2	15.42	294.46
48	3.4	12.91	377.30	5.3	25.01	471.47	3.2	12.59	391.68	4.0	14.43	365.35
49	2.3	11.71	519.13	3.9	16.81	431.11	4.1	15.38	377.66	2.4	7.92	325.06
50	3.1	14.07	461.25	0.9	3.95	430.44	1.6	8.29	516.06	3.4	15.80	459.93
51	2.1	6.19	291.50	0.4	1.79	437.00	0.9	3.83	421.01	1.5	5.30	363.18
52	0.8	3.87	503.42	0.6	4.21	748.33	0.8	4.82	613.37	0.3	1.62	532.72
Total	723.4			748.3			699.86			716.4		
Max	55.2	67.32	121.98	63.8	73.61	115.45	57.07	78.59	137.71	53.1	66.05	124.32
MW	32			32			32			32		

Table 7 contd...

Table 4.7. Tahasilwise weekly rainfall (mm) variation in Jalgaon district (1961-2016)

MW	Tahasil									District Average		
	Parola			Raver			Yawal					
	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)
01	0.4	1.61	458.55	0.5	2.50	518.69	0.5	2.23	481.60	0.6	2.70	441.20
02	1.1	5.94	522.75	0.6	4.09	665.45	1.8	7.73	441.85	0.8	4.14	462.80
03	0.2	1.36	633.73	0.5	1.71	348.13	0.5	1.91	371.92	0.7	3.17	434.20
04	0.6	2.31	386.81	0.6	3.15	527.28	0.0	0.00	0.00	0.2	1.16	519.80
05	0.3	2.04	628.29	0.7	3.13	461.86	0.3	1.34	470.59	0.5	2.88	534.70
06	0.1	0.94	748.33	0.3	2.27	699.83	0.4	1.59	371.89	0.5	2.85	541.70
07	0.9	5.82	629.52	1.4	7.47	533.79	0.3	2.17	639.04	0.6	3.43	547.50
08	1.2	4.94	418.39	0.6	4.03	632.75	0.9	5.34	583.14	1.3	5.33	399.10
09	0.2	0.85	527.66	0.7	3.01	421.87	0.2	0.95	549.40	0.6	2.90	406.40
10	0.3	1.38	423.36	0.6	4.28	704.89	0.5	2.78	554.57	0.7	3.05	446.00
11	1.4	4.43	326.18	2.2	6.55	300.78	3.6	12.63	347.13	1.7	6.27	361.60
12	0.4	2.94	748.33	0.8	4.31	515.14	0.5	2.97	600.01	0.7	3.81	536.00
13	0.4	1.70	484.41	1.2	6.35	547.05	0.5	2.37	449.74	0.9	4.56	460.30
14	0.9	4.22	463.63	0.1	0.75	748.33	0.1	0.40	748.33	0.2	1.28	571.20
15	0.2	0.97	602.41	0.1	1.00	748.33	1.4	6.32	458.46	0.4	2.04	530.70
16	0.1	0.53	748.33	0.7	4.44	663.01	0.1	0.67	748.33	0.3	1.54	575.70
17	0.3	2.14	748.33	0.0	0.00	0.00	0.1	0.53	748.33	0.1	0.90	498.10
18	0.1	0.94	748.33	0.4	2.41	692.12	0.2	1.36	633.73	0.5	2.80	529.10
19	2.5	11.11	450.88	0.6	2.43	412.86	1.8	7.500	428.76	1.5	5.90	362.20
20	0.5	1.82	377.27	1.5	4.98	337.43	0.2	0.87	360.07	0.7	2.75	366.50
21	0.7	4.53	617.44	2.0	9.33	473.05	2.9	10.68	364.75	1.7	6.40	381.00
22	4.5	11.73	263.61	2.4	11.70	494.45	2.8	12.06	436.15	4.3	11.83	268.60
23	17.9	30.88	172.94	23.3	41.54	178.40	15.6	34.04	217.99	19.0	36.08	177.60
24	26.1	30.94	118.61	32.0	49.00	153.01	27.2	39.95	146.78	30.7	38.84	116.30
25	26.3	32.18	122.29	29.8	35.55	119.24	32.2	50.67	157.26	30.1	39.58	122.60
26	37.4	35.27	94.32	42.0	47.96	114.13	43.9	53.85	122.56	42.3	47.79	103.30
27	35.5	37.17	104.75	44.3	47.57	107.45	39.6	42.23	106.56	41.8	44.43	98.50

Table 7 contd...

MW	Tahasil									District Average		
	Parola			Raver			Yawal					
	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)	RF (mm)	S. D.	C. V. (%)
28	35.9	36.37	101.41	34.9	36.79	105.52	42.6	39.82	93.40	40.4	39.22	90.500
29	36.4	27.81	76.34	36.4	31.09	85.46	46.3	34.75	75.04	40.3	33.06	76.10
30	42.2	35.49	84.09	48.4	43.11	88.99	54.6	48.93	89.57	47.0	41.56	83.00
31	39.2	45.06	114.91	40.3	39.37	97.65	41.2	38.12	92.54	44.6	49.72	102.50
32	40.2	43.83	108.99	58.6	83.20	141.91	58.1	92.37	158.87	53.1	66.59	114.20
33	32.2	37.37	116.21	38.8	38.11	98.31	27.1	35.40	130.67	35.9	41.74	107.40
34	29.4	37.50	127.58	35.4	40.02	113.05	35.1	44.35	126.45	37.6	42.22	105.60
35	41.5	43.76	105.35	44.2	45.30	102.39	29.5	29.55	100.03	40.2	41.81	96.60
36	37.9	44.35	116.95	40.5	45.01	111.20	38.9	46.08	118.32	38.2	46.87	114.50
37	23.1	30.31	131.29	25.0	29.42	117.69	27.0	40.69	150.98	24.8	33.73	126.20
38	21.0	25.50	121.29	28.3	32.88	116.20	27.9	37.48	134.17	28.0	35.68	119.30
39	20.3	27.51	135.25	20.3	28.97	142.78	20.6	34.86	169.42	20.4	32.20	148.00
40	19.4	30.89	159.04	17.5	25.73	147.33	18.7	32.83	175.15	17.0	26.99	146.60
41	12.5	27.80	222.08	17.1	39.73	232.09	8.3	17.86	215.79	14.1	41.95	254.10
42	4.3	19.74	461.28	4.9	11.81	239.30	6.6	15.51	236.47	4.9	13.91	268.30
43	5.7	17.70	312.74	4.9	13.75	279.94	3.3	17.35	518.67	4.4	14.31	304.70
44	1.8	5.67	318.42	3.0	15.64	521.23	1.4	6.76	500.65	2.9	10.72	344.60
45	2.3	7.74	333.00	3.4	9.52	283.72	1.5	6.41	442.37	2.6	8.15	293.00
46	3.4	13.90	405.11	2.3	11.99	518.89	3.6	14.11	390.37	4.9	17.48	345.10
47	4.9	16.54	339.75	4.6	15.87	342.25	1.6	4.77	300.15	4.2	13.18	299.10
48	3.1	11.68	373.83	4.9	21.9	451.61	2.3	8.51	373.09	3.3	13.76	389.20
49	2.8	13.62	485.28	4.4	16.45	370.73	4.0	13.1	324.49	3.1	12.78	390.30
50	1.5	5.26	345.97	1.1	5.71	529.55	1.6	8.47	531.54	2.0	9.60	435.70
51	1.3	5.88	466.67	1.1	6.68	590.25	0.8	4.35	524.08	0.9	4.00	421.70
52	0.5	3.47	748.33	1.0	4.69	493.50	1.1	5.32	496.17	0.7	3.92	549.50
Total	623.2			711.1			681.9			698.87		
Max	42.2	35.49	84.09	58.6	83.2	141.91	58.1	92.37	158.87	53.11	66.59	114.2
MW	30			32			32			32		

4.8. Tahasilwise Weekly Rainy Days

The variation in weekly rainy days is good indication for recording of concentration of rainfall in the particular week. The data on tahasilwise weekly rainy days variation are presented in Table 8. In general, rain started from 23 MW and ends at 41 MW for all the tahasils of Jalgaon district. In district average, the total number of rainy days recorded were 40. The highest number of rainy days were 3 recorded in 29, 30, 31 and 32 MW, 2 recorded in 24, 25, 26, 27, 28, 33, 34, 35 and 36 MW and rest of all the weeks recorded 0 and 1 rainy days. All the rainy days were concentrated within 23 to 41 MW.

Maximum number of rainy days were observed in Amalner (56.01 to 191.51 per cent variation), Bhadagaon (52.92 to 196.24 per cent variation), Bodhwada (52.25 to 179.38 per cent variation), Bhusawal (55.61 to 179.27 per cent variation), Chalisgaon (64.19 to 177.34 per cent variation), Chopada (57.86 to 204.99 per cent variation), Dharangaon (48.5 to 178.48 per cent variation), Erandol (57.96 to 213.47 per cent variation), Jalgaon (55.13 to 204.37 per cent variation), Jamner (54.26 to 207.45 per cent variation), Muktainagar (53.36 to 164.13 per cent variation), Pachora (58.79 to 182.32 per cent variation), Parola (66.18 to 168.16 per cent variation), Raver (66.18 to 168.16 per cent variation) and Yawal (54.56 to 188.07 per cent variation) from 23 to 41 MW. From 23 to 41 MW it was observed that there was a trend of continuous rainy days with less variation. For rest of the other weeks, there was no rainfall. Similar study was carried out by Jadhav *et al.* (1999) for scarcity zone of Maharashtra.

Table 4.8. Tahasilwise weekly rainy days (numbers) variation in Jalgaon district (1961-2016)

MW	Tahasil											
	Amalner			Bhadagaon			Bhodwada			Bhusawal		
	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)
01	0	0.23	424.12	0	0.23	424.12	0	0.35	386.61	0	0.23	424.12
02	0	0.23	424.12	0	0.26	363.82	0	0.30	553.70	0	0.23	424.12
03	0	0.13	748.33	0	0.23	424.12	0	0.45	424.12	0	0.32	451.26
04	0	0.13	748.33	0	0.13	748.33	0	0.00	0.00	0	0.00	0.00
05	0	0.23	424.12	0	0.13	748.33	0	0.13	748.33	0	0.00	0.00
06	0	0.32	451.26	0	0.19	524.32	0	0.19	524.32	0	0.19	524.32
07	0	0.23	424.12	0	0.13	748.33	0	0.19	524.32	0	0.13	748.33
08	0	0.35	386.61	0	0.32	451.26	0	0.52	363.82	0	0.66	371.57
09	0	0.35	386.61	0	0.00	0.00	0	0.32	451.26	0	0.19	524.32
10	0	0.23	424.12	0	0.19	524.32	0	0.31	291.29	0	0.23	424.12
11	0	0.26	363.82	0	0.37	341.36	0	0.45	424.12	0	0.45	424.12
12	0	0.32	451.26	0	0.37	524.32	0	0.32	451.26	0	0.27	748.33
13	0	0.26	363.82	0	0.35	386.61	0	0.44	490.61	0	0.19	524.32
14	0	0.19	524.32	0	0.13	748.33	0	0.13	748.33	0	0.13	748.33
15	0	0.32	451.26	0	0.13	748.33	0	0.23	424.12	0	0.32	451.26
16	0	0.00	0.00	0	0.13	748.33	0	0.30	553.70	0	0.23	424.12
17	0	0.13	748.33	0	0.13	748.33	0	0.13	748.33	0	0.13	748.33
18	0	0.19	524.32	0	0.30	553.70	0	0.19	524.32	0	0.19	524.32
19	0	0.39	441.68	0	0.60	371.00	0	0.37	341.36	0	0.47	375.62
20	0	0.19	524.32	0	0.29	322.26	0	0.26	363.82	0	0.26	363.82
21	0	0.30	553.70	0	0.26	363.82	0	0.67	266.97	0	0.50	308.88
22	0	0.59	219.32	0	0.85	215.33	0	0.78	258.39	0	0.60	259.65
23	1	1.28	152.04	1	1.41	127.36	1	1.47	124.39	1	1.28	146.30
24	2	1.45	95.67	2	1.52	85.24	2	1.65	83.03	1	1.31	90.31
25	2	1.38	73.38	2	1.47	88.41	2	1.81	89.90	2	1.61	93.08
26	2	1.69	88.30	2	1.55	78.85	3	1.93	74.12	2	1.83	84.01

Table 8 contd....

MW	Tahasil											
	Amalner			Bhadagaon			Bhodwada			Bhusawal		
	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)
27	2	1.85	72.90	2	1.35	63.19	3	1.81	58.65	2	1.79	73.09
28	2	1.64	66.08	2	1.72	74.47	3	1.85	55.94	3	1.81	66.39
29	2	1.58	64.26	3	1.81	66.39	3	1.77	52.57	3	1.83	64.17
30	3	1.54	56.01	3	1.46	52.92	3	1.85	54.14	3	1.59	55.61
31	3	1.83	69.37	3	1.79	63.44	3	2.04	66.8	3	1.91	71.77
32	3	1.85	72.37	3	1.60	58.12	4	1.88	52.25	3	1.71	57.37
33	2	1.60	74.25	2	1.49	63.81	3	2.09	76.87	2	1.61	77.06
34	2	1.51	82.15	2	1.57	68.65	3	1.99	78.50	2	1.55	78.45
35	2	1.96	89.14	3	1.77	65.04	3	2.00	74.15	2	1.98	84.82
36	2	1.79	97.13	2	1.67	72.60	2	1.95	92.59	2	1.87	104.47
37	1	1.26	89.44	1	1.33	96.65	2	1.62	106.6	1	1.69	117.12
38	1	1.44	111.70	2	1.49	99.29	2	1.81	103.52	2	1.73	115.12
39	1	1.43	133.02	1	1.69	127.54	1	1.60	120.83	1	1.44	134.2
40	1	1.14	127.57	1	1.28	137.54	1	1.35	118.49	1	1.31	143.97
41	1	1.33	191.51	1	1.16	196.24	1	1.25	179.38	1	1.02	179.27
42	0	0.59	219.32	0	0.77	226.75	0	0.91	231.16	0	0.57	246.31
43	0	0.76	264.58	0	0.83	273.23	0	0.93	325.02	0	0.54	304.06
44	0	0.60	371.00	0	0.53	330.89	0	0.62	291.29	0	0.54	304.06
45	0	0.59	277.36	0	0.43	343.25	0	0.62	291.29	0	0.48	338.45
46	0	0.88	272.56	0	0.82	306.13	0	0.80	280.91	0	0.72	368.64
47	0	0.69	277.65	0	0.70	261.49	0	0.81	265.91	0	0.53	330.89
48	0	0.53	330.89	0	0.76	328.49	0	0.82	416.65	0	0.49	459.95
49	0	0.56	351.52	0	0.67	266.97	0	0.82	384.97	0	0.56	351.52
50	0	0.49	459.95	0	0.65	407.19	0	0.37	341.36	0	0.39	441.68
51	0	0.23	424.12	0	0.29	322.26	0	0.29	322.26	0	0.32	451.26
52	0	0.19	524.32	0	0.27	748.33	0	0.27	748.33	0	0.27	748.33
Total	35			38			48			37		

Table 8 contd....

Table 4.8. Tahasilwise weekly rainy days (numbers) variation in Jalgaon district (1961-2016)

MW	Tahasil											
	Chalisgaon			Chopada			Dharangaon			Erandol		
	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)
01	0	0.23	424.12	0	0.23	424.12	0	0.19	524.32	0	0.13	748.33
02	0	0.49	459.95	0	0.23	424.12	0	0.44	490.61	0	0.23	424.12
03	0	0.19	524.32	0	0.23	424.12	0	0.32	451.26	0	0.23	424.12
04	0	0.13	748.33	0	0.00	0.00	0	0.23	424.12	0	0.23	424.12
05	0	0.35	386.61	0	0.13	748.33	0	0.26	363.82	0	0.27	748.33
06	0	0.13	748.33	0	0.23	424.12	0	0.13	748.33	0	0.13	748.33
07	0	0.13	748.33	0	0.19	524.32	0	0.23	424.12	0	0.19	524.32
08	0	0.42	588.37	0	0.33	266.97	0	0.44	311.01	0	0.32	451.26
09	0	0.19	524.32	0	0.35	386.61	0	0.32	451.26	0	0.13	748.33
10	0	0.33	266.97	0	0.30	553.70	0	0.41	384.97	0	0.27	748.33
11	0	0.23	424.12	0	0.44	490.61	0	0.38	307.48	0	0.35	386.61
12	0	0.39	441.68	0	0.27	748.33	0	0.27	748.33	0	0.30	553.70
13	0	0.44	490.61	0	0.23	424.12	0	0.37	341.36	0	0.30	553.70
14	0	0.00	0.00	0	0.13	748.33	0	0.44	490.61	0	0.00	0.00
15	0	0.00	0.00	0	0.27	748.33	0	0.23	424.12	0	0.13	748.33
16	0	0.00	0.00	0	0.27	748.33	0	0.13	748.33	0	0.13	748.33
17	0	0.13	748.33	0	0.00	0.00	0	0.19	524.32	0	0.00	0.00
18	0	0.35	386.61	0	0.19	524.32	0	0.19	524.32	0	0.19	524.32
19	0	0.57	459.25	0	0.71	329.55	0	0.89	311.01	0	0.41	384.97
20	0	0.19	524.32	0	0.23	424.12	0	0.26	363.82	0	0.41	384.97
21	0	0.63	272.33	0	0.29	322.26	0	0.52	363.82	0	0.31	291.29
22	0	0.80	213.11	0	0.65	228.43	0	0.73	178.48	0	0.64	255.84
23	1	1.57	115.38	1	1.29	153.73	1	1.47	122.86	1	1.21	123.55
24	2	1.46	73.58	2	1.45	92.30	2	1.63	69.78	2	1.28	80.29
25	2	1.97	113.61	2	1.62	97.62	3	1.77	69.73	2	1.62	91.52
26	2	1.54	75.11	2	1.78	75.64	3	2.03	68.93	2	1.58	75.42

Table 8 contd....

MW	Tahasil											
	Chalisgaon			Chopada			Dharangaon			Erandol		
	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)
27	2	1.53	65.35	3	1.97	71.81	4	1.96	56.09	3	1.56	61.09
28	2	1.76	78.25	3	1.83	67.28	3	1.90	58.70	3	1.78	68.60
29	2	1.31	64.19	3	1.90	70.87	3	1.88	54.74	3	1.64	58.18
30	2	1.60	68.34	3	1.82	58.44	4	1.84	48.50	3	1.69	57.96
31	2	1.42	69.13	3	1.76	59.82	3	2.14	62.09	3	1.82	68.47
32	3	1.70	66.76	3	1.78	57.86	3	1.95	56.68	3	1.70	58.19
33	2	1.56	74.86	2	1.47	69.91	3	1.96	69.62	2	1.58	67.36
34	2	1.96	82.49	2	1.68	70.71	2	1.80	74.53	2	1.59	71.91
35	2	1.82	66.91	2	1.76	80.24	3	2.16	73.91	3	2.10	81.27
36	3	2.06	73.14	2	2.10	92.04	3	2.31	88.58	2	1.71	89.42
37	2	1.75	81.77	2	1.72	110.42	2	1.79	92.12	1	1.47	117.43
38	2	1.60	83.67	1	1.30	112.36	2	1.44	84.81	2	1.66	108.23
39	2	1.71	99.94	1	1.42	112.04	2	1.92	114.23	1	1.26	119.26
40	1	1.44	115.43	1	1.33	128.83	1	1.40	97.96	1	1.29	116.41
41	1	1.36	177.34	1	1.06	204.99	1	1.47	178.48	1	1.14	213.47
42	0	0.72	202.82	0	0.67	188.24	0	0.89	226.00	0	0.39	216.42
43	0	0.82	306.13	0	0.69	386.61	0	0.99	240.26	0	0.55	281.69
44	0	0.62	291.29	0	0.45	424.12	0	0.65	304.58	0	0.29	322.26
45	0	0.59	277.36	0	0.47	263.9	0	0.66	284.45	0	0.43	343.25
46	0	0.93	236.20	0	1.03	304.11	0	0.97	245.97	0	0.88	351.62
47	0	0.64	328.06	0	0.67	266.97	0	1.06	257.58	0	0.73	271.01
48	0	0.60	483.92	0	0.37	524.32	0	0.86	322.26	0	0.47	375.62
49	0	0.49	459.95	0	0.64	355.9	0	0.70	355.63	0	0.77	428.58
50	0	0.43	343.25	0	0.49	459.95	0	0.56	351.52	0	0.48	338.45
51	0	0.42	588.37	0	0.19	524.32	0	0.32	451.26	0	0.23	424.12
52	0	0.30	553.70	0	0.19	524.32	0	0.30	553.700	0	0.57	459.25
Total	37			39			53			40		

Table 8 contd....

Table 4.8. Tahasilwise weekly rainy days (numbers) variation in Jalgaon district (1961-2016)

MW	Tahasil											
	Jalgaon			Jamner			Muktainagar			Pachora		
	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)
01	0	0.23	424.12	0	0.35	386.61	0	0.23	424.12	0	0.23	424.12
02	0	0.23	424.12	0	0.27	748.33	0	0.32	451.26	0	0.23	424.12
03	0	0.26	363.82	0	0.30	553.70	0	0.35	386.61	0	0.23	424.12
04	0	0.37	341.36	0	0.00	0.00	0	0.19	524.32	0	0.13	748.33
05	0	0.19	524.32	0	0.13	748.33	0	0.19	524.32	0	0.19	524.32
06	0	0.27	748.33	0	0.19	524.32	0	0.19	524.32	0	0.13	748.33
07	0	0.23	424.12	0	0.19	524.32	0	0.19	524.32	0	0.13	748.33
08	0	0.41	384.97	0	0.32	451.26	0	0.55	387.53	0	0.35	386.61
09	0	0.35	386.61	0	0.35	386.61	0	0.37	341.36	0	0.39	441.68
10	0	0.45	424.12	0	0.35	386.61	0	0.37	341.36	0	0.23	424.12
11	0	0.53	330.89	0	0.35	386.61	0	0.48	338.45	0	0.29	322.26
12	0	0.43	343.25	0	0.32	451.26	0	0.30	553.70	0	0.37	524.32
13	0	0.51	284.69	0	0.44	490.61	0	0.30	553.70	0	0.42	588.37
14	0	0.19	524.32	0	0.13	748.33	0	0.13	748.33	0	0.13	748.33
15	0	0.13	748.33	0	0.13	748.33	0	0.30	553.70	0	0.13	748.33
16	0	0.19	524.32	0	0.13	748.33	0	0.23	424.12	0	0.13	748.33
17	0	0.00	0.00	0	0.00	0.00	0	0.13	748.33	0	0.13	748.33
18	0	0.32	451.26	0	0.13	748.33	0	0.19	524.32	0	0.19	524.32
19	0	0.47	263.90	0	0.32	451.26	0	0.48	338.45	0	0.43	343.25
20	0	0.26	363.82	0	0.23	424.12	0	0.33	266.97	0	0.23	424.12
21	0	0.52	363.82	0	0.46	285.18	0	0.62	291.29	0	0.23	424.12
22	0	0.80	204.09	0	0.62	218.47	0	0.70	261.49	0	0.54	232.21
23	1	1.41	127.36	1	1.27	124.96	1	1.62	131.31	1	1.33	130.46
24	2	1.56	96.89	2	1.50	86.33	2	1.55	72.94	2	1.54	84.48
25	2	1.57	92.64	2	1.55	92.37	2	1.85	76.07	2	1.49	92.43
26	2	1.94	82.84	2	1.46	68.02	3	1.92	72.67	2	1.56	76.65

Table 8 contd.....

MW	Tahasil											
	Jalgaon			Jamner			Muktainagar			Pachora		
	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)
27	3	1.94	71.55	3	1.69	67.31	3	1.87	60.57	2	1.47	63.15
28	3	1.77	62.20	3	1.65	62.18	3	1.97	62.09	2	1.64	66.08
29	3	1.86	65.91	3	1.59	61.05	3	1.86	55.99	3	1.51	58.79
30	3	1.80	63.28	3	1.63	59.91	3	1.85	53.36	3	1.65	60.73
31	3	2.02	70.21	3	2.00	72.26	3	1.97	58.87	3	1.72	60.74
32	3	1.71	55.13	3	1.68	54.26	4	1.95	53.49	3	1.75	63.14
33	2	1.87	80.53	2	1.79	73.09	3	1.89	65.48	3	1.48	59.08
34	2	1.70	85.77	2	1.82	78.93	3	1.80	69.90	2	1.61	65.19
35	2	1.89	82.47	3	1.95	74.83	3	2.01	68.56	3	1.88	67.85
36	2	1.9	88.16	2	1.71	92.09	2	1.86	77.54	2	1.78	76.67
37	2	1.68	110.95	1	1.50	115.11	2	1.67	92.43	2	1.51	91.71
38	2	1.55	99.66	2	1.64	105.53	2	1.96	95.34	2	1.69	105.25
39	1	1.20	112.36	1	1.44	123.79	2	1.87	113.98	1	1.58	122.95
40	1	1.30	123.32	1	1.26	128.04	1	1.39	117.91	1	1.18	143.31
41	1	1.09	204.37	1	1.11	207.45	1	1.41	164.13	1	1.04	182.35
42	0	0.75	280.2	0	0.90	278.94	0	0.83	201.19	0	0.75	209.73
43	0	0.59	219.32	0	0.74	318.05	0	0.68	237.98	0	0.77	307.48
44	0	0.74	318.05	0	0.53	330.89	0	0.62	313.37	0	0.59	277.36
45	0	0.74	230.59	0	0.63	272.33	0	0.63	272.33	0	0.62	291.29
46	0	1.03	337.81	0	0.66	284.45	0	0.76	264.58	0	1.01	298.87
47	0	0.43	343.25	0	0.83	273.23	0	0.82	288.73	0	0.76	264.58
48	0	0.44	311.01	0	0.54	433.17	0	0.94	352.32	0	0.62	313.37
49	0	0.43	343.25	0	0.72	401.09	0	0.81	348.42	0	0.65	304.58
50	0	0.51	405.42	0	0.37	341.36	0	0.39	441.68	0	0.66	371.57
51	0	0.33	266.97	0	0.23	424.12	0	0.39	441.68	0	0.37	341.36
52	0	0.42	588.37	0	0.13	748.33	0	0.40	748.33	0	0.19	524.32
Total	40			40			51			40		

Table 8 contd....

Table 4.8. Tahasilwise weekly rainy days (numbers) variation in Jalgaon district (1961-2016)

MW	Tahasil											
	Parola			Raver			Yawal			District Average		
	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)
01	0	0.23	424.12	0	0.19	524.32	0	0.19	524.32	0	0.19	460.77
02	0	0.42	588.37	0	0.27	748.33	0	0.32	451.26	0	0.25	493.36
03	0	0.13	748.33	0	0.23	424.12	0	0.26	363.82	0	0.22	475.74
04	0	0.35	386.61	0	0.19	524.32	0	0.00	0.00	0	0.12	374.54
05	0	0.19	524.32	0	0.23	424.12	0	0.19	524.32	0	0.17	530.79
06	0	0.13	748.33	0	0.27	748.33	0	0.26	363.82	0	0.18	606.61
07	0	0.19	524.32	0	0.35	386.61	0	0.19	524.32	0	0.17	554.84
08	0	0.41	384.97	0	0.42	588.37	0	0.23	424.12	0	0.34	413.25
09	0	0.19	524.32	0	0.32	451.26	0	0.13	748.33	0	0.23	450.19
10	0	0.23	424.12	0	0.27	748.33	0	0.30	553.70	0	0.26	461.35
11	0	0.31	291.29	0	0.40	280.91	0	0.47	263.90	0	0.33	358.44
12	0	0.27	748.33	0	0.32	451.26	0	0.37	524.32	0	0.29	550.91
13	0	0.30	553.70	0	0.30	553.70	0	0.44	490.61	0	0.30	472.70
14	0	0.35	386.61	0	0.13	748.33	0	0.13	748.33	0	0.12	577.39
15	0	0.13	748.33	0	0.13	748.33	0	0.39	441.68	0	0.17	582.19
16	0	0.13	748.33	0	0.30	553.7	0	0.13	748.33	0	0.13	564.44
17	0	0.13	748.33	0	0.00	0.00	0	0.13	748.33	0	0.07	483.95
18	0	0.13	748.33	0	0.13	748.33	0	0.13	748.33	0	0.18	571.96
19	0	0.41	384.97	0	0.23	424.12	0	0.76	471.29	0	0.45	379.45
20	0	0.26	363.82	0	0.37	341.36	0	0.13	748.33	0	0.23	413.60
21	0	0.42	588.37	0	0.51	405.42	0	0.52	363.82	0	0.38	364.34
22	0	0.59	219.32	0	0.43	343.25	0	0.62	291.29	0	0.57	239.91
23	1	1.36	131.44	1	1.45	130.81	1	1.20	143.30	1	1.19	132.35
24	2	1.63	82.92	2	1.54	95.02	1	1.40	94.54	2	1.28	85.55
25	2	1.41	83.30	2	1.52	81.78	2	1.59	88.09	2	1.40	88.26
26	2	1.57	70.44	2	1.71	78.34	2	1.78	78.65	2	1.49	76.53

Table 8 contd....

MW	Tahasil											
	Parola			Raver			Yawal			District Average		
	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)	RD (nos)	S. D.	C. V. (%)
27	3	1.52	57.01	2	1.88	79.85	2	1.88	80.95	2	1.52	66.84
28	3	1.68	63.00	2	1.61	78.91	3	1.79	71.55	3	1.52	66.78
29	3	1.58	58.71	2	1.72	70.12	3	1.72	54.56	3	1.48	61.37
30	3	1.65	56.34	3	1.85	73.95	3	1.92	57.21	3	1.48	58.45
31	3	1.91	68.16	3	1.94	69.71	3	1.71	61.62	3	1.60	66.16
32	3	1.72	59.57	3	1.76	66.18	3	1.80	65.51	3	1.53	59.79
33	2	1.79	77.11	2	1.67	75.43	2	1.71	89.42	2	1.45	72.93
34	2	1.67	79.71	2	1.77	75.72	2	1.85	84.36	2	1.48	76.46
35	2	1.88	75.66	2	1.88	76.20	2	1.84	89.75	2	1.67	76.72
36	2	1.92	84.71	2	1.75	80.27	2	1.97	92.85	2	1.63	86.82
37	2	1.44	95.98	1	1.49	102.90	1	1.75	117.91	1	1.37	102.57
38	1	1.41	96.55	2	1.54	86.96	2	1.61	103.37	1	1.38	100.76
39	1	1.55	108.33	1	1.55	118.77	1	1.69	115.72	1	1.35	118.46
40	1	1.50	123.37	1	1.39	121.96	1	1.25	115.16	1	1.13	123.95
41	1	1.21	188.61	1	1.41	168.16	1	1.11	188.07	1	1.05	188.25
42	0	0.66	284.45	0	0.80	204.09	0	0.81	188.03	0	0.63	226.91
43	0	1.09	290.18	0	0.60	259.65	0	0.43	343.25	0	0.60	290.50
44	0	0.62	291.29	0	0.44	490.61	0	0.51	405.42	0	0.47	337.77
45	0	0.53	330.89	0	0.69	277.65	0	0.35	386.61	0	0.49	298.73
46	0	0.82	306.13	0	0.59	409.88	0	0.81	325.86	0	0.74	306.25
47	0	0.96	282.57	0	0.70	261.49	0	0.40	280.91	0	0.60	283.62
48	0	0.64	328.06	0	0.56	351.52	0	0.41	384.97	0	0.51	381.10
49	0	0.79	441.68	0	0.65	304.58	0	0.86	343.25	0	0.57	362.79
50	0	0.52	363.82	0	0.37	524.32	0	0.32	451.26	0	0.41	402.85
51	0	0.45	424.12	0	0.44	490.61	0	0.32	451.26	0	0.27	423.21
52	0	0.27	748.33	0	0.39	441.68	0	0.32	451.26	0	0.26	607.39
Total	43			41			37			40		

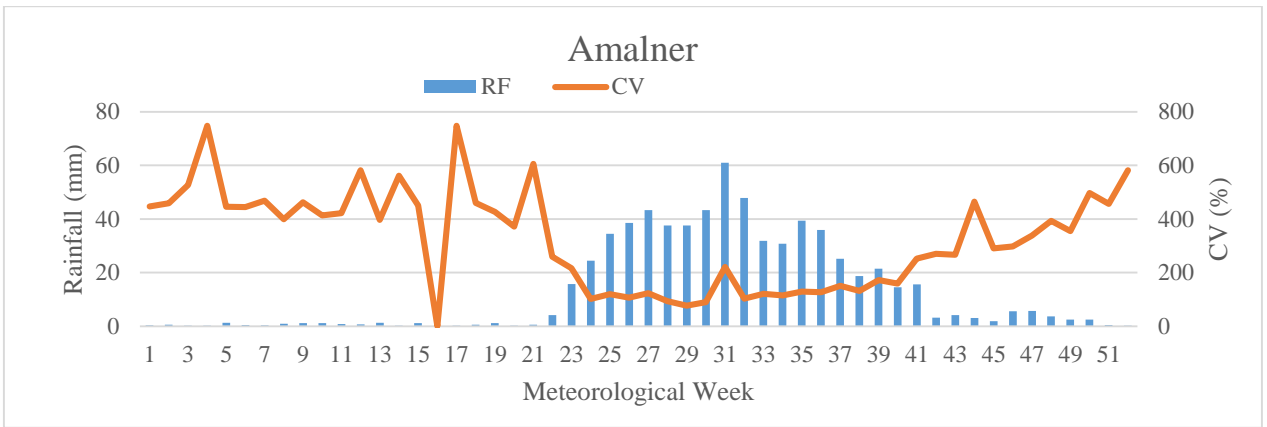


Fig.37: Weekly rainfall of Amalner tahasil (1961-2016)

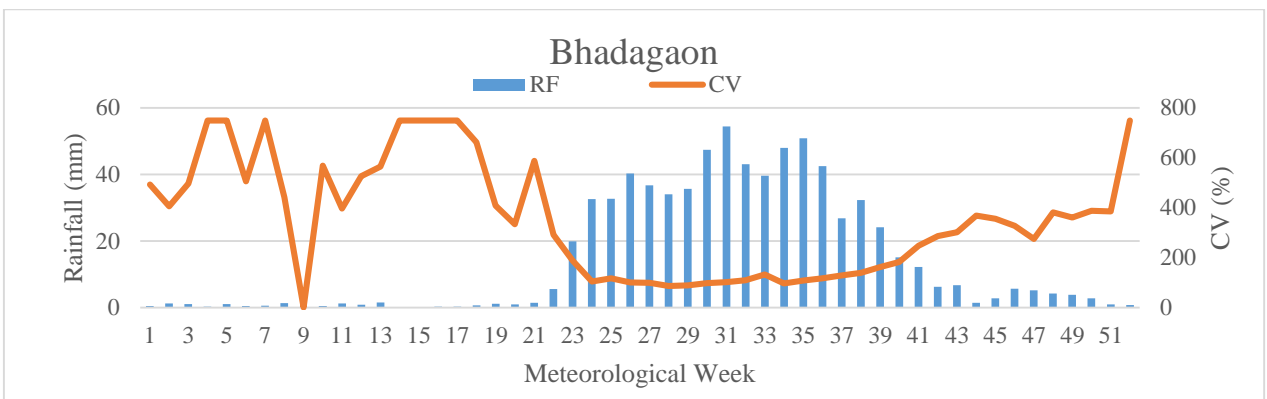


Fig.38: Weekly rainfall of Bhadagaon tahasil (1961-2016)

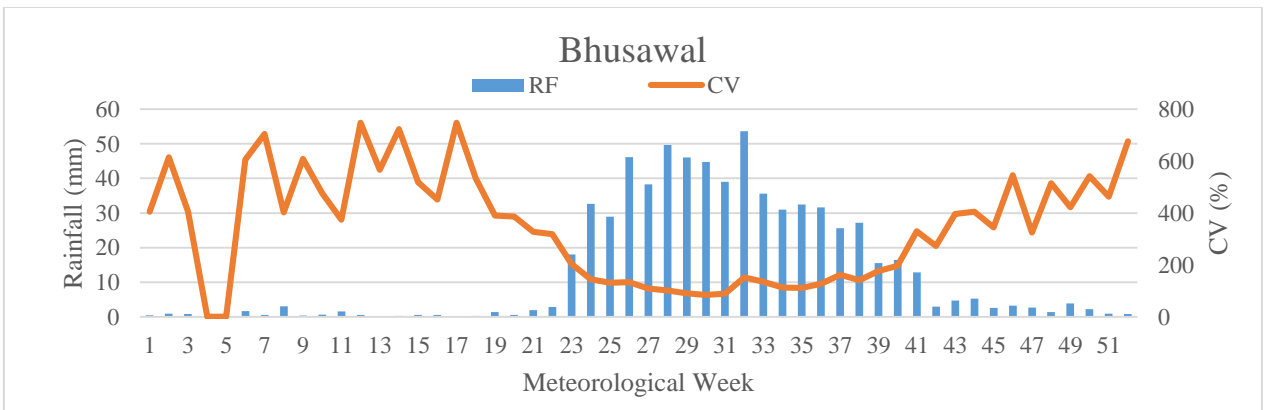


Fig.39: Weekly rainfall of Bhusawal tahasil (1961-2016)

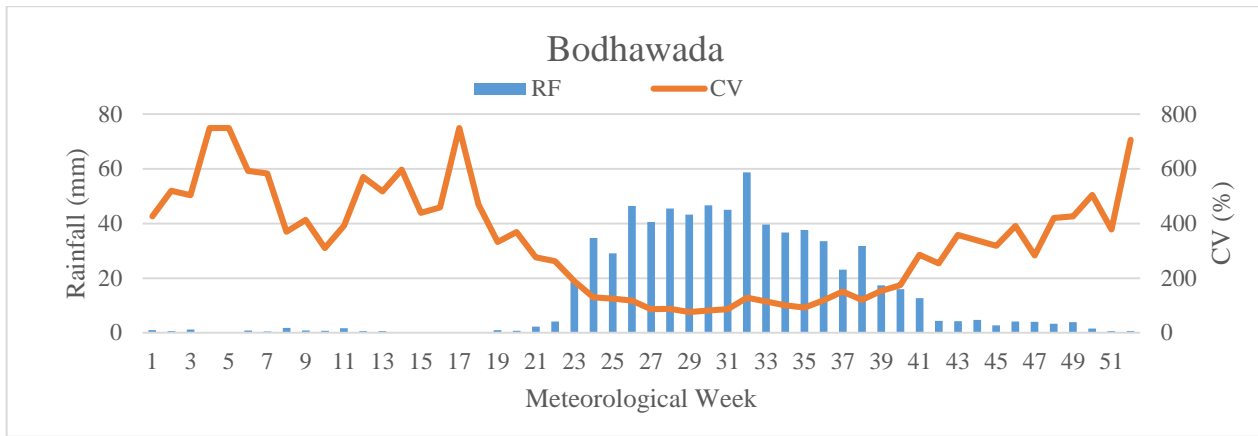


Fig.40: Weekly rainfall of Bodhawada tahasil (1961-2016)

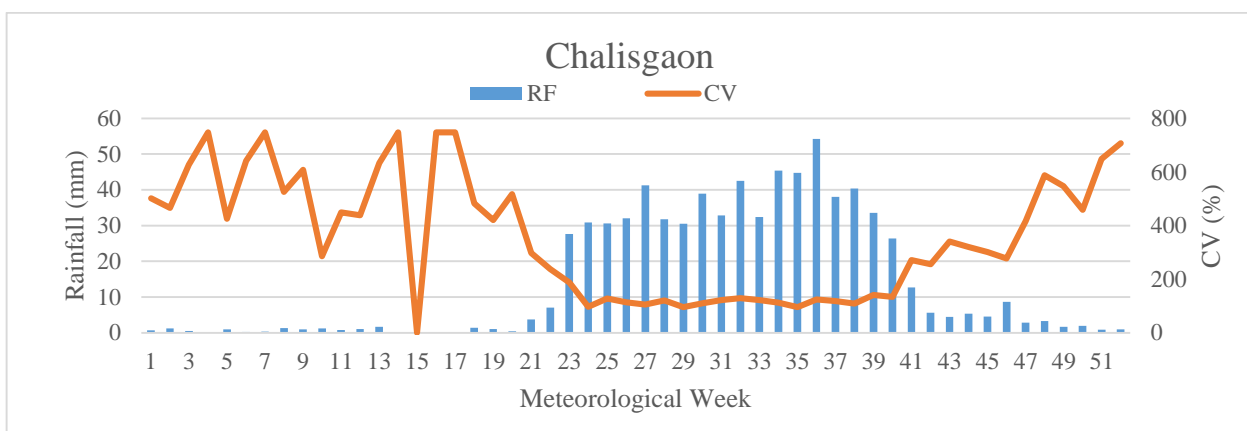


Fig.41: Weekly rainfall of Chalisgaon tahasil (1961-2016)

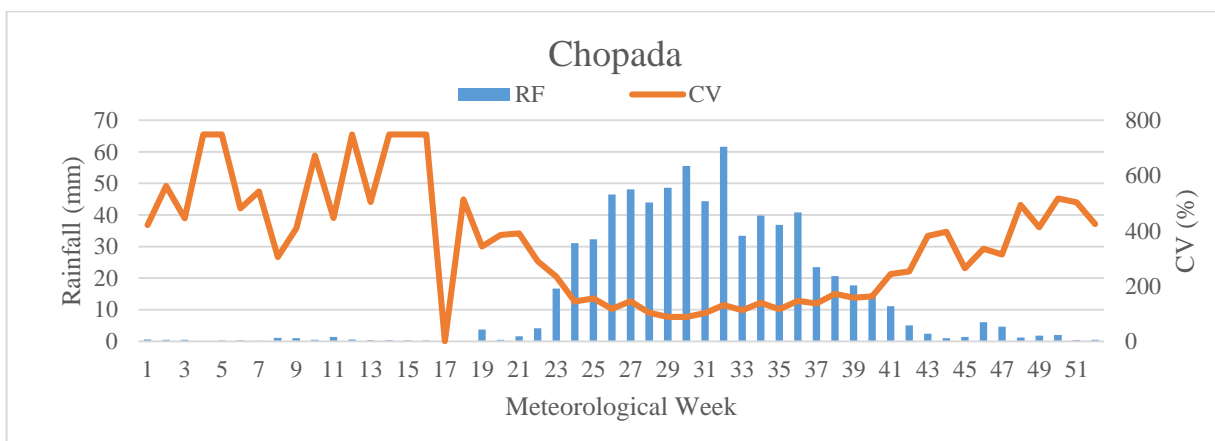


Fig.42: Weekly rainfall of Chopada tahasil (1961-2016)

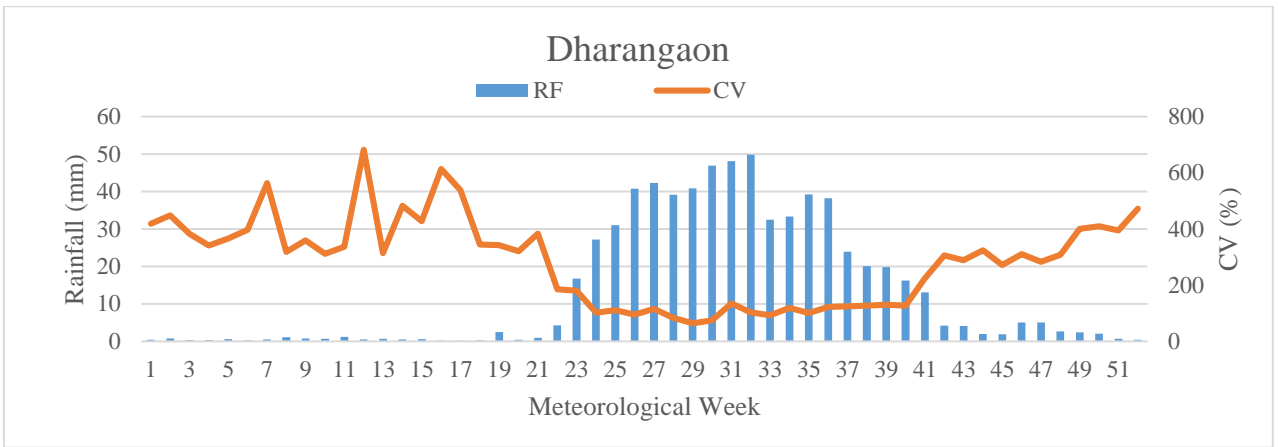


Fig.43: Weekly rainfall of Dharangaon tahasil (1961-2016)

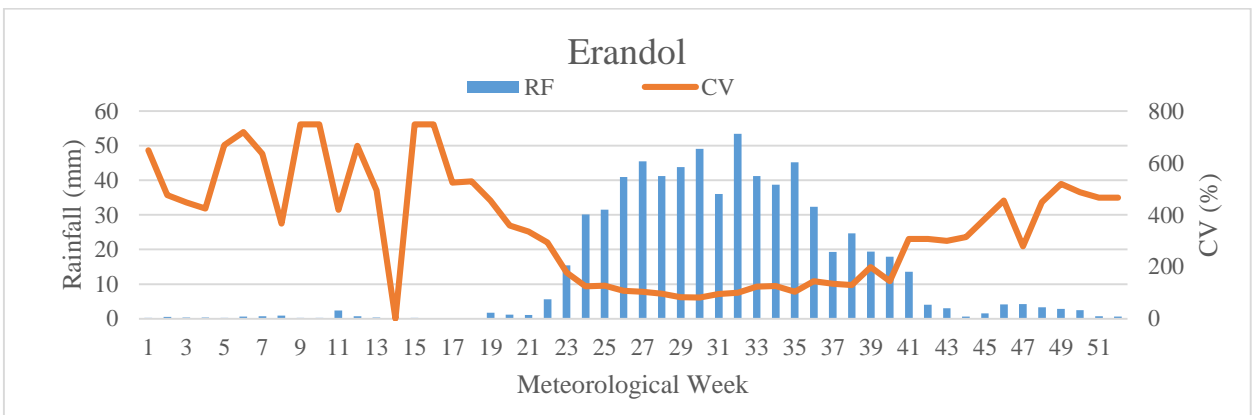


Fig.44: Weekly rainfall of Erandol tahasil (1961-2016)

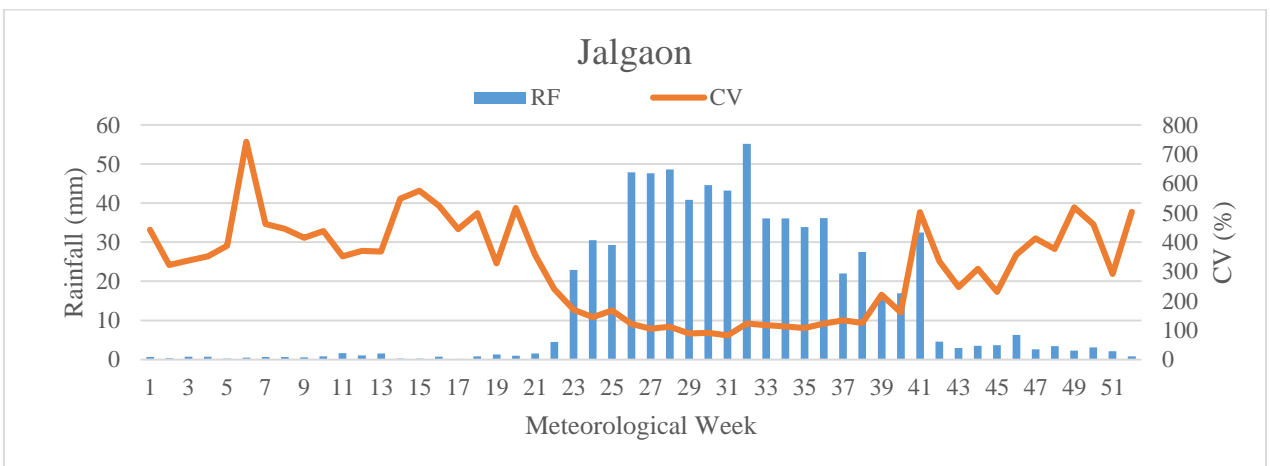


Fig.45: Weekly rainfall of Jalgaon tahasil (1961-2016)

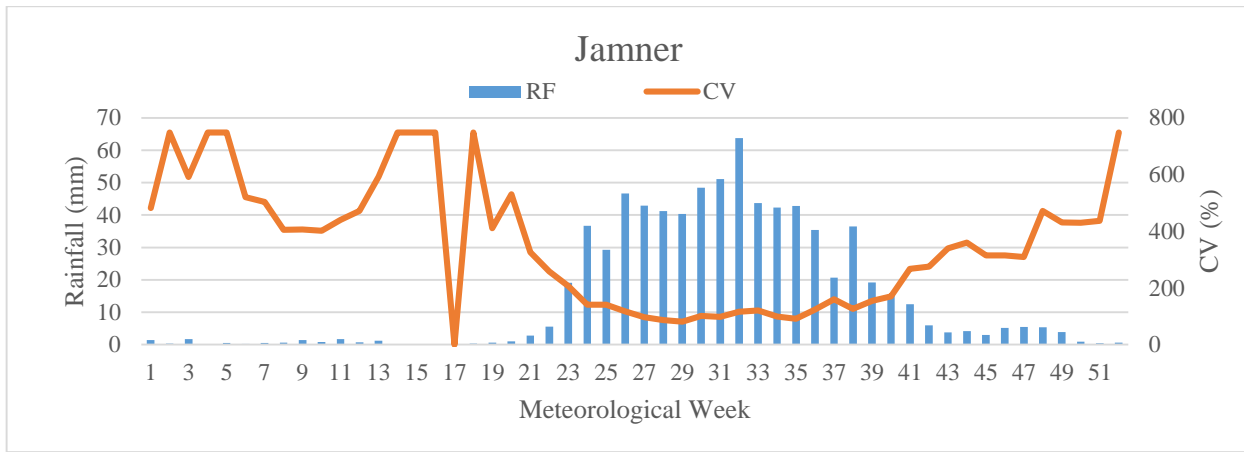


Fig.46: Weekly rainfall of Jamner tahasil (1961-2016)

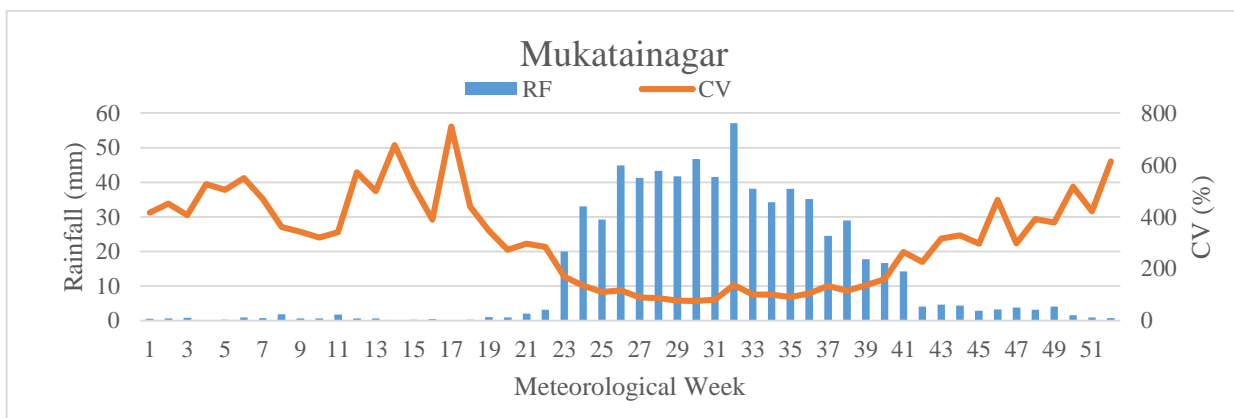


Fig.47: Weekly rainfall of Muktainagar tahasil (1961-2016)

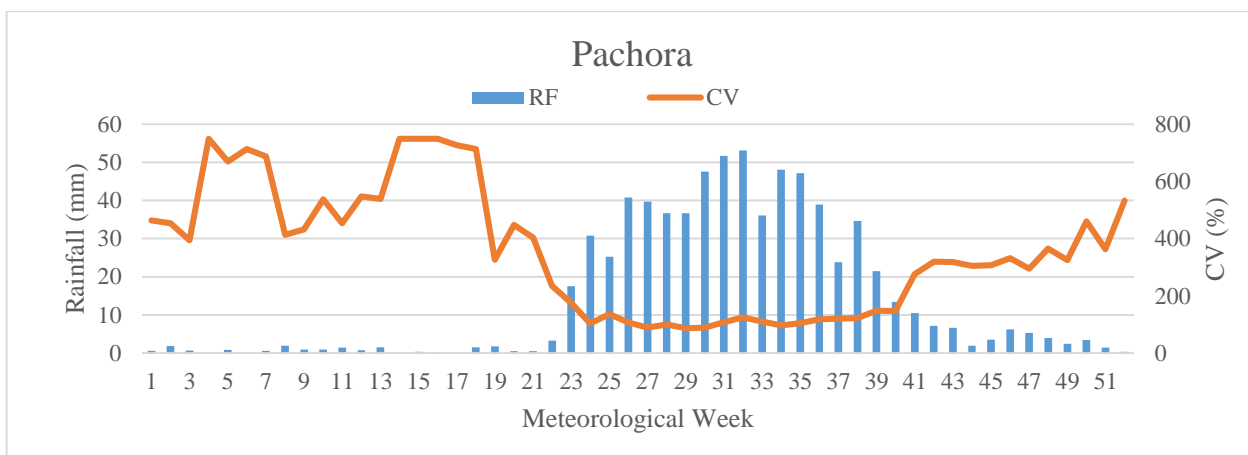


Fig.48: Weekly rainfall of Pachora tahasil (1961-2016)

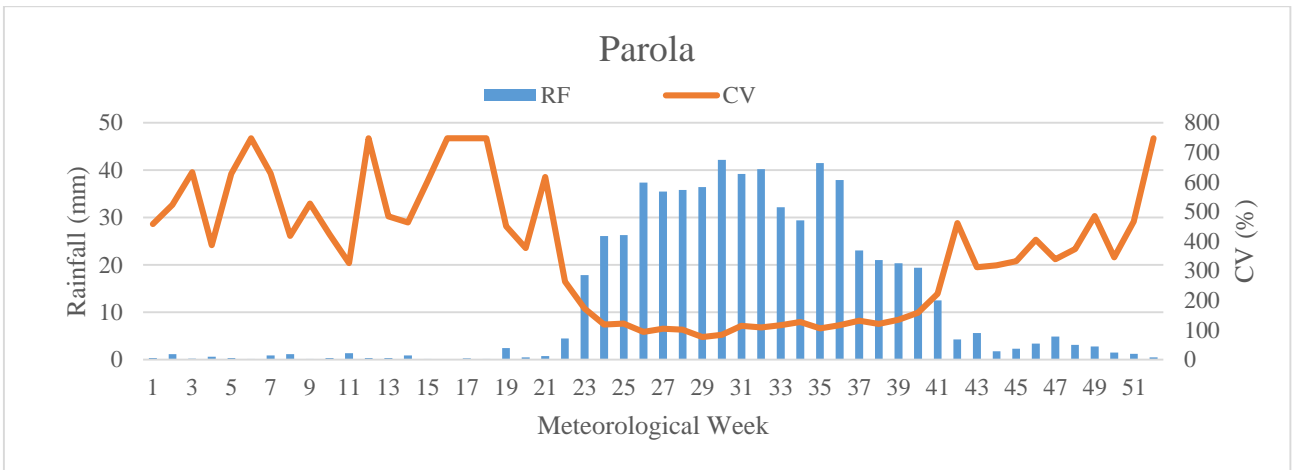


Fig.49: Weekly rainfall of Parola tahasil (1961-2016)

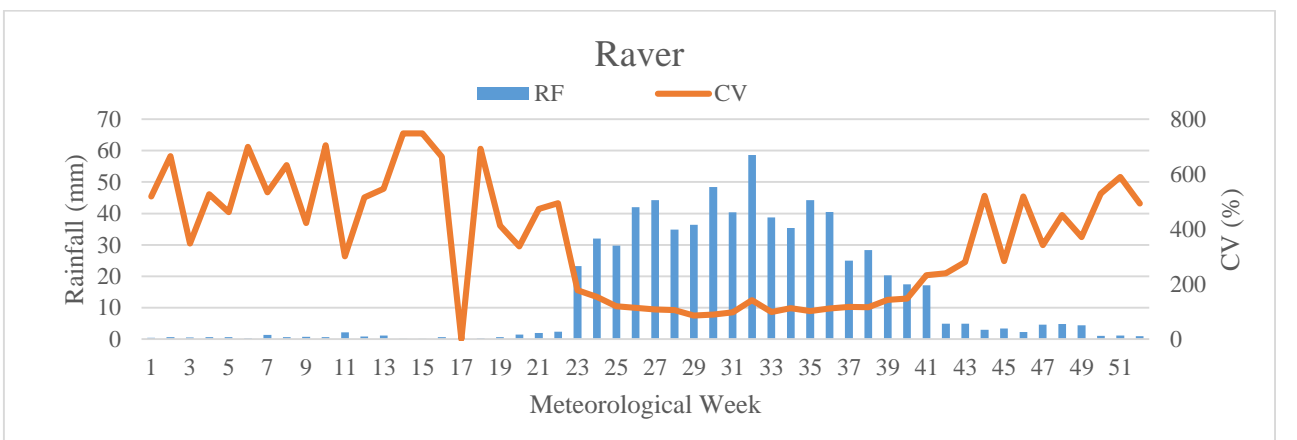


Fig.50: Weekly rainfall of Raver tahasil (1961-2016)

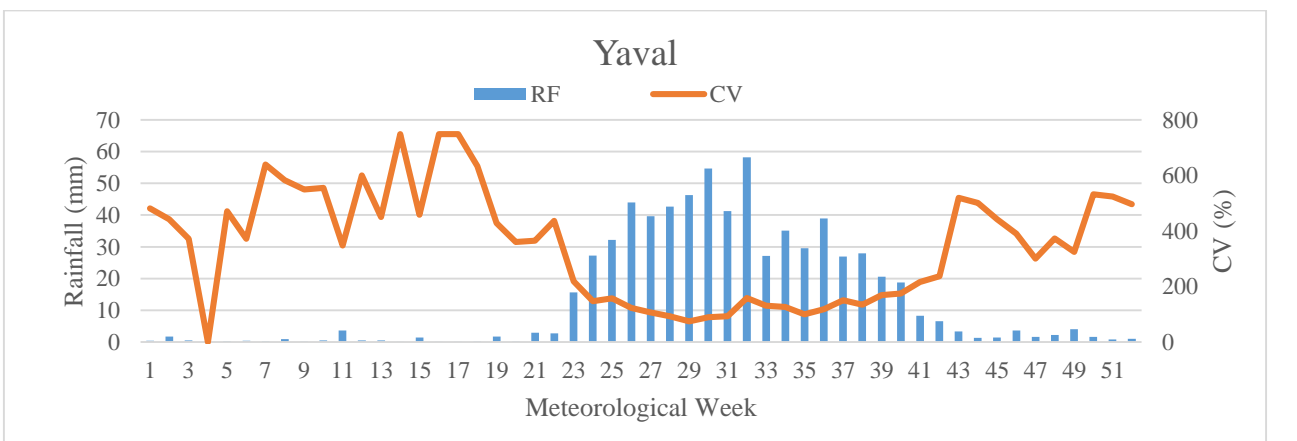


Fig.51: Weekly rainfall of Yaval tahasil (1961-2016)

4.9. Meteorological Drought:

On the basis of average value of annual rainfall received for long term over an area, the drought is classified as no drought (rainfall less than 25 per cent of normal rainfall), moderate drought (rainfall less than 50 per cent of normal rainfall) and severe drought (rainfall less than 75 per cent of normal rainfall) and is presented in Table 9 and figure 7. This was necessary tool for working out the cropping pattern according to conditions prevailing in tahasils. For the planner, it is also useful for working out the contingency crop planning based on severity of the drought or onset of rains. The data showed that average number of drought years for Jalgaon district for no drought, moderate drought and severe drought were 42 years, 10 years and 1 years with contribution of 79, 19 and 2 per cent, respectively.

In Bhadagaon tahasil, number of no drought, moderate drought and severe drought years were 41, 15 and 0 years and its contribution was 73, 27 and 0 per cent, respectively. Similarly, in Amalner tahasil, number of no drought, moderate drought and severe drought year were 42, 13 and 1 years and its contribution was 75, 23 and 2 per cent respectively. In Chopada, number of no drought, moderate drought and severe drought year were 42, 14 and 0 years and its contribution was 75, 26 and 0 per cent, respectively. In Raver, number of no drought, moderate drought and severe drought year were 42, 13 and 1 years and its contribution was 75, 23 and 2 per cent, respectively. In Yawal, number of no drought, moderate drought and severe drought year were 42, 14 and 0 years and its contribution was 75, 25 and 0 per cent, respectively. In Jalgaon, number of no drought (43 years), moderate drought (12 years) and severe drought (1 year) was observed while contribution was 77, 21 and 2 per cent, respectively. In Jamner, number of no drought, moderate drought and severe drought year were 44, 10 and 2 years and its contribution was 79, 18 and 3 per cent, respectively. In Pachora, number of no drought, moderate drought and severe drought year were 44, 10 and 0 years and its contribution was 79, 18 and 3 per cent, respectively. In Chalisgaon, number of no drought, moderate drought and severe drought year were 45, 10 and 0 years and its contribution was 80, 18 and 2 per cent, respectively. In Dharangaon, number of no drought, moderate drought and severe drought year were 45, 11 and 0 years and its contribution was 80, 20 and 0 per cent, respectively.

In Erandol, number of no drought, moderate drought and severe drought year were 46, 9 and 1 years and its contribution was 82, 16 and 2 per cent, respectively. In Bodhwada, number of no drought, moderate drought and severe drought year were 47, 8 and 1 years and its contribution was 84, 14 and 2 per cent, respectively, In Bhusawal, number of no drought, moderate drought and severe drought year were 47, 7 and 2 years and its contribution was 84, 13 and 4 per cent, respectively. In Parola, number of no drought, moderate drought and severe

drought year were 47, 9 and 0 years and its contribution was 84, 16 and 0 per cent, respectively. In Muktainagar, number of no drought, moderate drought and severe drought year were 48, 8 and 0 years and its contribution was 86, 14 and 0 per cent, respectively.

Thus, the data revealed that all the tahasils were favorable for assured rainfall conditions useful for cultivation of various crops during the year. However, considering the intensity of moderate and severe drought conditions, necessary measures for conservations of moisture should be adopted at tahasil level. The contingency cropping should be adopted under the severity of drought.

Similar work was done by Mary *et al.* (2005), Bhakar *et al.* (2007), Rai *et al.* (2008), Halikatti *et al.* (2010) and Amrutha Rani and Shreedhar (2014) at Salur (Tamil Nadu), Kota region, Madhepura (Bihar), Dharwad (Karnataka) and Belgaum (Karnataka), respectively.

Table 4.9: Tahasilwise meteorological drought of Jalgaon district (1961-2016)

Sr. No.	Year	Amalner			Bhadagaon			Bhodhwada		
		Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition
1	1961	495.1	-25.78	Moderate	603.4	-17.29	No Drought	914.1	28.44	No Drought
2	1962	384.8	-42.31	Moderate	526.5	-27.83	Moderate	780.2	9.62	No Drought
3	1963	663.3	-0.57	No Drought	1101.5	50.97	No Drought	641.3	-9.89	No Drought
4	1964	405.1	-39.27	Moderate	1045.1	43.24	No Drought	791.6	11.22	No Drought
5	1965	605.8	-9.19	No Drought	641.3	-12.09	No Drought	579.0	-18.64	No Drought
6	1966	413.6	-38.00	Moderate	812.1	11.31	No Drought	588.4	-17.33	No Drought
7	1967	696.5	4.40	No Drought	656.1	-10.07	No Drought	403.8	-43.26	Moderate
8	1968	718.8	7.74	No Drought	479.0	-34.34	Moderate	327.4	-53.99	Severe
9	1969	811.2	21.59	No Drought	1130.0	54.88	No Drought	818.7	15.03	No Drought
10	1970	618.3	-7.31	No Drought	1049.5	43.85	No Drought	961.5	35.16	No Drought
11	1971	509.0	-23.70	No Drought	490.5	-32.76	Moderate	357.7	-49.73	Moderate
12	1972	384.5	-42.36	Moderate	366.6	-49.75	Moderate	462.6	-35.00	Moderate
13	1973	782.9	17.35	No Drought	1050.0	43.91	No Drought	779.9	9.58	No Drought
14	1974	849.0	27.26	No Drought	480.6	-34.12	Moderate	523.9	-26.38	Moderate
15	1975	1278.8	91.68	No Drought	1142.6	56.61	No Drought	784.8	10.26	No Drought
16	1976	1512.5	126.71	No Drought	896.0	22.81	No Drought	535.0	-24.82	No Drought
17	1977	991.0	48.54	No Drought	821.2	12.55	No Drought	813.8	14.34	No Drought
18	1978	613.5	-8.03	No Drought	434.0	-40.51	Moderate	810.0	13.81	No Drought
19	1979	829.9	24.39	No Drought	715.3	-1.95	No Drought	1113.2	56.41	No Drought
20	1980	548.6	-17.76	No Drought	647.7	-11.22	No Drought	981.8	37.96	No Drought
21	1981	644.4	-3.40	No Drought	637.7	-12.59	No Drought	970.0	36.29	No Drought
22	1982	503.0	-24.60	No Drought	441.3	-39.51	Moderate	615.5	-13.51	No Drought
23	1983	881.4	32.11	No Drought	925.5	26.85	No Drought	712.1	0.05	No Drought
24	1984	751.3	12.61	No Drought	494.1	-32.27	Moderate	505.7	-28.93	Moderate
25	1985	555.8	-16.68	No Drought	529.4	-27.43	Moderate	592.5	-16.74	No Drought
26	1986	388.9	-41.70	Moderate	521.6	-28.50	Moderate	680.3	-4.40	No Drought
27	1987	689.1	3.29	No Drought	824.8	13.05	No Drought	677.0	-4.87	No Drought
28	1988	753.8	12.99	No Drought	958.2	31.33	No Drought	778.0	9.31	No Drought
29	1989	587.0	-12.01	No Drought	1042.9	42.94	No Drought	866.0	21.68	No Drought
30	1990	800.8	20.03	No Drought	915.0	25.41	No Drought	909.8	27.83	No Drought

Table 9 contd...

Table 4.9: Tahasilwise meteorological drought of Jalgaon district (1961-2016)

Sr. No.	Year	Amalner			Bhadagaon			Bhodhwada		
		Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition
31	1991	513.6	-23.01	No Drought	536.0	-26.53	Moderate	589.4	-17.17	No Drought
32	1992	1639.6	145.77	No Drought	738.0	1.15	No Drought	759.2	6.68	No Drought
33	1993	493.4	-26.04	Moderate	749.0	2.66	No Drought	825.7	16.02	No Drought
34	1994	651.5	-2.34	No Drought	683.0	-6.38	No Drought	916.3	28.75	No Drought
35	1995	390.4	-41.48	Moderate	613.8	-15.86	No Drought	732.4	2.90	No Drought
36	1996	651.0	-2.41	No Drought	833.6	14.25	No Drought	601.7	-15.44	No Drought
37	1997	575.0	-13.80	No Drought	966.0	32.40	No Drought	757.0	6.30	No Drought
38	1998	999.2	49.77	No Drought	1083.3	48.48	No Drought	1056.7	48.48	No Drought
39	1999	628.0	-5.86	No Drought	659.0	-9.67	No Drought	590.6	-17.01	No Drought
40	2000	322.2	-51.70	Severe	472.0	-35.30	Moderate	656.4	-7.76	No Drought
41	2001	598.3	-10.31	No Drought	644.3	-11.68	No Drought	715.6	0.55	No Drought
42	2002	530.0	-20.55	No Drought	605.1	-17.06	No Drought	779.8	9.57	No Drought
43	2003	847.0	26.96	No Drought	1094.0	49.94	No Drought	942.7	32.46	No Drought
44	2004	717.0	7.47	No Drought	628.0	-13.92	No Drought	654.4	-8.04	No Drought
45	2005	398.2	-40.31	Moderate	662.2	-9.23	No Drought	571.4	-19.71	No Drought
46	2006	950.8	42.52	No Drought	1033.8	41.69	No Drought	1262.1	77.33	No Drought
47	2007	713.7	6.98	No Drought	531.6	-27.13	Moderate	744.5	4.61	No Drought
48	2008	506.0	-24.15	No Drought	699.2	-4.16	No Drought	460.1	-35.35	Moderate
49	2009	677.6	1.57	No Drought	689.0	-5.56	No Drought	656.9	-7.69	No Drought
50	2010	721.4	8.13	No Drought	773.8	6.06	No Drought	690.6	-2.95	No Drought
51	2011	478.8	-28.22	Moderate	631.8	-13.40	No Drought	529.1	-25.64	Moderate
52	2012	408.3	-38.79	Moderate	364.8	-49.99	Moderate	364.7	-48.75	Moderate
53	2013	769.5	15.34	No Drought	928.3	27.23	No Drought	835.4	17.39	No Drought
54	2014	661.5	-0.84	No Drought	661.0	-9.39	No Drought	596.2	-16.22	No Drought
55	2015	391.1	-41.37	Moderate	462.2	-36.64	Moderate	538.5	-24.33	No Drought
56	2016	458.2	-31.31	Moderate	734.0	0.60	No Drought	750.6	5.46	No Drought

Abstract of drought years and per cent contribution of Amalner, Bhadagon and Bodhwada

Sr. No	Condition	Amalner		Bhadagaon		Bhodhwada	
		No. of Years	(%)	No. of Years	(%)	No. of Years	(%)
01	No Drought	42	75%	41	73%	47	84%
02	Moderate Drought	13	23%	15	27%	8	14%
03	Severe Drought	1	2%	0	0%	1	2%

Table 9 contd...

Table 4.9: Tahasilwise meteorological drought of Jalgaon district (1961-2016)

Sr. No.	Year	Bhusawal			Chalisgaon			Chopada		
		Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition
1	1961	985.8	46.01	No Drought	865.4	18.28	No Drought	955.2	34.24	No Drought
2	1962	757.9	12.25	No Drought	869.2	18.80	No Drought	472.5	-33.59	Moderate
3	1963	555.9	-17.6612	No Drought	793.7	8.48	No Drought	537.0	-24.52	No Drought
4	1964	857.7	27.04	No Drought	580.1	-20.71	No Drought	641.9	-9.78	No Drought
5	1965	625.1	-7.41	No Drought	658.3	-10.02	No Drought	463.0	-34.95	Moderate
6	1966	411.3	-39.07	Moderate	716.7	-2.04	No Drought	433.5	-39.07	Moderate
7	1967	432.2	-35.98	Moderate	454.2	-37.91	Moderate	455.0	-36.05	Moderate
8	1968	172.7	-74.42	Severe	673.9	-7.89	No Drought	913.1	28.33	No Drought
9	1969	666.6	-1.26	No Drought	1145.0	56.49	No Drought	989.7	39.09	No Drought
10	1970	840.8	24.53	No Drought	1009.0	37.91	No Drought	1169.6	64.38	No Drought
11	1971	330.5	-51.04	Severe	478.2	-34.63	Moderate	491.0	-30.99	Moderate
12	1972	641.4	-4.99	No Drought	504.3	-31.07	Moderate	533.8	-24.97	No Drought
13	1973	750.9	11.22	No Drought	718.5	-1.79	No Drought	759.7	6.77	No Drought
14	1974	502.7	-25.54	Moderate	678.8	-7.22	No Drought	598.7	-15.85	No Drought
15	1975	701.9	3.96	No Drought	748.0	2.23	No Drought	812.4	14.17	No Drought
16	1976	574.0	-14.98	No Drought	385.1	-47.36	Moderate	1004.3	41.15	No Drought
17	1977	757.9	12.25	No Drought	641.3	-12.34	No Drought	699.0	-1.75	No Drought
18	1978	675.6	0.06	No Drought	547.6	-25.15	No Drought	581.0	-18.34	No Drought
19	1979	831.4	23.14	No Drought	644.4	-11.92	No Drought	644.0	-9.48	No Drought
20	1980	622.7	-7.76	No Drought	678.2	-7.30	No Drought	753.0	5.83	No Drought
21	1981	761.8	12.83	No Drought	744.0	1.69	No Drought	373.4	-47.52	Moderate
22	1982	631.7	-6.43	No Drought	546.6	-25.29	No Drought	440.0	-38.15	Moderate
23	1983	591.7	-12.35	No Drought	822.0	12.35	No Drought	514.8	-27.64	Moderate
24	1984	430.2	-36.27	Moderate	759.0	3.74	No Drought	426.0	-40.12	Moderate
25	1985	627.5	-7.05	No Drought	613.0	-16.21	No Drought	640.0	-10.05	No Drought
26	1986	807.0	19.53	No Drought	713.4	-2.49	No Drought	596.4	-16.17	No Drought
27	1987	518.0	-23.27	No Drought	1106.6	51.25	No Drought	883.4	24.15	No Drought
28	1988	794.6	17.69	No Drought	1003.5	37.15	No Drought	668.0	-6.11	No Drought
29	1989	760.0	12.56	No Drought	1262.0	72.49	No Drought	625.0	-12.15	No Drought
30	1990	766.6	13.54	No Drought	893.0	22.05	No Drought	871.0	22.41	No Drought

Table 9 contd...

Table 4.9: Tahasilwise meteorological drought of Jalgaon district (1961-2016)

Sr. No.	Year	Bhusawal			Chalisgaon			Chopada		
		Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition
31	1991	555.9	-17.66	No Drought	693.0	-5.28	No Drought	602.0	-15.39	No Drought
32	1992	666.5	-1.28	No Drought	690.0	-5.69	No Drought	844.0	18.62	No Drought
33	1993	878.3	30.09	No Drought	891.0	21.78	No Drought	841.0	18.20	No Drought
34	1994	945.2	40.00	No Drought	527.0	-27.97	Moderate	925.0	30.01	No Drought
35	1995	700.3	3.73	No Drought	528.0	-27.83	Moderate	662.0	-6.96	No Drought
36	1996	607.3	-10.05	No Drought	849.0	16.04	No Drought	631.0	-11.32	No Drought
37	1997	626.8	-7.16	No Drought	1003.0	37.09	No Drought	756.0	6.25	No Drought
38	1998	971.2	43.85	No Drought	1097.0	49.94	No Drought	999.2	40.43	No Drought
39	1999	486.2	-27.99	Moderate	632.0	-13.62	No Drought	430.0	-39.57	Moderate
40	2000	701.9	3.96	No Drought	333.4	-54.43	Severe	472.2	-33.63	Moderate
41	2001	574.2	-14.95	No Drought	666.0	-8.97	No Drought	548.8	-22.87	No Drought
42	2002	788.9	16.85	No Drought	925.8	26.54	No Drought	877.4	23.32	No Drought
43	2003	898.5	33.08	No Drought	1171.	60.05	No Drought	1105.2	55.33	No Drought
44	2004	586.8	-13.08	No Drought	506.0	-30.84	Moderate	622.0	-12.58	No Drought
45	2005	535.2	-20.73	No Drought	379.4	-48.14	Moderate	443.0	-37.74	Moderate
46	2006	1420.6	110.42	No Drought	1039.0	42.01	No Drought	1457.0	104.78	No Drought
47	2007	619.8	-8.20	No Drought	624.6	-14.63	No Drought	775.0	8.92	No Drought
48	2008	335.0	-50.38	Moderate	649.8	-11.18	No Drought	555.2	-21.97	No Drought
49	2009	683.7	1.27	No Drought	747.0	2.10	No Drought	863.8	21.40	No Drought
50	2010	821.6	21.69	No Drought	823.2	12.52	No Drought	1025.0	44.06	No Drought
51	2011	542.2	-19.69	No Drought	695.8	-4.90	No Drought	695.2	-2.29	No Drought
52	2012	366.2	-45.76	Moderate	388.0	-46.97	Moderate	485.9	-31.71	Moderate
53	2013	942.4	39.59	No Drought	817.8	11.78	No Drought	1186.9	66.81	No Drought
54	2014	685.3	1.51	No Drought	735.1	0.47	No Drought	877.1	23.27	No Drought
55	2015	641.1	-5.04	No Drought	518.6	-29.12	Moderate	499.9	-29.74	Moderate
56	2016	842.5	24.79	No Drought	787.9	7.69	No Drought	719.4	1.11	No Drought

Abstract of drought years and per cent contribution of Bhusawal, Chalisgaon and Chopada

Sr. No	Condition	Bhusawal		Chalisgaon		Chopada	
		No. of Years	(%)	No. of Years	(%)	No. of Years	(%)
01	No Drought	47	84%	45	80%	42	75%
02	Moderate Drought	7	13%	10	18%	14	25%
03	Severe Drought	2	4%	1	2%	0	0%

Table 9 contd...

Table 4.9: Tahasilwise meteorological drought of Jalgaon district (1961-2016)

Sr. No.	Year	Dharangaon			Erandol			Jalgaon		
		Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition
1	1961	705.6	5.74	No Drought	968.6	41.40	No Drought	883.5	22.14	No Drought
2	1962	450.2	-32.53	Moderate	482.4	-29.58	Moderate	755.2	4.40	No Drought
3	1963	596.9	-10.55	No Drought	679.9	-0.75	No Drought	663.4	-8.29	No Drought
4	1964	526.5	-21.10	No Drought	608.6	-11.15	No Drought	847.1	17.11	No Drought
5	1965	496.3	-25.62	Moderate	530.2	-22.60	No Drought	569.3	-21.30	No Drought
6	1966	447.9	-32.88	Moderate	533.0	-22.19	No Drought	557.9	-22.87	No Drought
7	1967	562.2	-15.75	No Drought	650.0	-5.11	No Drought	825.6	14.13	No Drought
8	1968	649.5	-2.66	No Drought	916.5	33.79	No Drought	469.3	-35.12	Moderate
9	1969	776.9	16.43	No Drought	572.0	-16.50	No Drought	901.6	24.64	No Drought
10	1970	815.7	22.24	No Drought	682.4	-0.38	No Drought	962.8	33.10	No Drought
11	1971	477.8	-28.40	Moderate	390.2	-43.04	Moderate	650.0	-10.14	No Drought
12	1972	423.6	-36.52	Moderate	413.8	-39.59	Moderate	477.4	-34.00	Moderate
13	1973	671.1	0.57	No Drought	728.2	6.30	No Drought	822.8	13.75	No Drought
14	1974	652.5	-2.21	No Drought	632.1	-7.72	No Drought	702.1	-2.94	No Drought
15	1975	937.1	40.44	No Drought	747.3	9.09	No Drought	851.0	17.64	No Drought
16	1976	1058	58.56	No Drought	645.4	-5.78	No Drought	709.2	-1.96	No Drought
17	1977	693.0	3.86	No Drought	623.4	-8.99	No Drought	820.2	13.39	No Drought
18	1978	511.8	-23.30	No Drought	623.5	-8.98	No Drought	793.6	9.71	No Drought
19	1979	663.0	-0.64	No Drought	680.0	-0.73	No Drought	792.8	9.60	No Drought
20	1980	579.9	-13.09	No Drought	375.9	-45.12	Moderate	666.2	-7.90	No Drought
21	1981	558.9	-16.24	No Drought	499.1	-27.14	Moderate	801.0	10.73	No Drought
22	1982	472.9	-29.13	Moderate	267.0	-61.02	Severe	648.8	-10.31	No Drought
23	1983	828.7	24.19	No Drought	940.5	37.30	No Drought	860.2	18.92	No Drought
24	1984	623.1	-6.62	No Drought	530.5	-22.56	No Drought	479.6	-33.70	Moderate
25	1985	589.1	-11.72	No Drought	409.5	-40.22	Moderate	459.4	-36.49	Moderate
26	1986	447.7	-32.91	Moderate	533.0	-22.19	No Drought	422.6	-41.58	Moderate
27	1987	749.3	12.29	No Drought	650.0	-5.11	No Drought	714.4	-1.24	No Drought
28	1988	644.3	-3.44	No Drought	916.5	33.79	No Drought	654.5	-9.52	No Drought
29	1989	560.8	-15.96	No Drought	572.0	-16.50	No Drought	1915.5	164.81	No Drought
30	1990	738.9	10.73	No Drought	1141.3	66.61	No Drought	995.7	37.65	No Drought

Table 9 contd...

Table 4.9: Tahasilwise meteorological drought of Jalgaon district (1961-2016)

Sr. No.	Year	Dharangaon			Erandol			Jalgaon		
		Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition
31	1991	527.2	-20.99	No Drought	749.7	9.44	No Drought	505.2	-30.16	Moderate
32	1992	1094.2	63.98	No Drought	838.0	22.33	No Drought	557.9	-22.87	No Drought
33	1993	655.3	-1.79	No Drought	682.0	-0.44	No Drought	384.9	-46.79	Moderate
34	1994	777.4	16.50	No Drought	659.0	-3.80	No Drought	559.6	-22.64	No Drought
35	1995	539.1	-19.21	No Drought	522.2	-23.77	No Drought	599.5	-17.12	No Drought
36	1996	628.4	-5.83	No Drought	535.0	-21.90	No Drought	577.1	-20.22	No Drought
37	1997	675.8	1.28	No Drought	794.0	15.91	No Drought	410.1	-43.30	Moderate
38	1998	1030.6	54.45	No Drought	1037.8	51.50	No Drought	792.0	9.49	No Drought
39	1999	620.3	-7.04	No Drought	717.1	4.68	No Drought	606.6	-16.14	No Drought
40	2000	436.1	-34.64	Moderate	505.2	-26.25	Moderate	732.0	1.19	No Drought
41	2001	657.0	-1.54	No Drought	701.0	2.33	No Drought	772.0	6.72	No Drought
42	2002	699.5	4.83	No Drought	825.4	20.49	No Drought	939.7	29.91	No Drought
43	2003	988.2	48.10	No Drought	1003.0	46.42	No Drought	1216.2	68.13	No Drought
44	2004	649.9	-2.60	No Drought	589.0	-14.02	No Drought	531.5	-26.52	Moderate
45	2005	467.5	-29.94	Moderate	509.0	-25.69	Moderate	506.5	-29.98	Moderate
46	2006	1283.3	92.32	No Drought	1334.1	94.76	No Drought	1444.1	99.64	No Drought
47	2007	748.6	12.19	No Drought	720.0	5.11	No Drought	752.7	4.05	No Drought
48	2008	544.9	-18.34	No Drought	663.0	-3.21	No Drought	422.7	-41.57	Moderate
49	2009	740.6	10.99	No Drought	865.0	26.28	No Drought	754.1	4.25	No Drought
50	2010	854.4	28.04	No Drought	864.5	26.20	No Drought	752.4	4.01	No Drought
51	2011	579.4	-13.17	No Drought	686.0	0.14	No Drought	735.7	1.70	No Drought
52	2012	482.7	-27.66	Moderate	488.0	-28.76	Moderate	320.2	-55.73	Severe
53	2013	1004.8	50.58	No Drought	932.2	36.09	No Drought	987.5	36.51	No Drought
54	2014	718.9	7.74	No Drought	904.4	32.03	No Drought	805.6	11.37	No Drought
55	2015	442.5	-33.69	Moderate	524.8	-23.39	No Drought	423.0	-41.52	Moderate
56	2016	611.5	-8.36	No Drought	768.4	12.17	No Drought	747.0	3.27	No Drought

Abstract of drought years and per cent contribution of Dharangaon, Erandol and Jalgaon

Sr. No	Condition	Dhargoon		Erandol		Jalgaon	
		No. of Years	(%)	No. of Years	(%)	No. of Years	(%)
01	No Drought	45	80%	46	82%	43	77%
02	Moderate Drought	11	20%	9	16%	12	21%
03	Severe Drought	0	0%	1	2%	1	2%

Table 9 contd...

Table 4.9: Tahasilwise meteorological drought of Jalgaon district (1961-2016)

Sr. No.	Year	Jamner			Muktainagar			Pachora		
		Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition
1	1961	842.4	12.59	No Drought	973.0	39.04	No Drought	657.2	-8.26	No Drought
2	1962	802.4	7.24	No Drought	734.0	4.88	No Drought	840.0	17.26	No Drought
3	1963	726.6	-2.89	No Drought	667.0	-4.69	No Drought	1029.4	43.69	No Drought
4	1964	725.5	-3.04	No Drought	883.0	26.18	No Drought	826.4	15.36	No Drought
5	1965	532.9	-28.78	Moderate	572.0	-18.26	No Drought	714.7	-0.23	No Drought
6	1966	765.4	2.29	No Drought	486.0	-30.55	Moderate	1083.7	51.27	No Drought
7	1967	375.4	-49.83	Moderate	566.0	-19.12	No Drought	699.6	-2.34	No Drought
8	1968	482.1	-35.57	Moderate	351.0	-49.84	Moderate	786.0	9.72	No Drought
9	1969	970.8	29.75	No Drought	705.0	0.74	No Drought	1080.9	50.88	No Drought
10	1970	1083.1	44.75	No Drought	1020.0	45.75	No Drought	1080.5	50.83	No Drought
11	1971	384.9	-48.56	Moderate	380.0	-45.70	Moderate	529.2	-26.13	Moderate
12	1972	283.7	-62.08	Severe	498.0	-28.84	Moderate	379.3	-47.05	Moderate
13	1973	808.9	8.11	No Drought	847.0	21.03	No Drought	1135.8	58.55	No Drought
14	1974	545.1	-27.15	Moderate	576.0	-17.69	No Drought	353.7	-50.63	Severe
15	1975	867.6	15.95	No Drought	779.0	11.31	No Drought	1057.5	47.62	No Drought
16	1976	496.0	-33.71	Moderate	686.0	-1.98	No Drought	655.5	-8.50	No Drought
17	1977	869.6	16.22	No Drought	760.0	8.60	No Drought	945.0	31.91	No Drought
18	1978	944.4	26.22	No Drought	763.0	9.03	No Drought	586.0	-18.20	No Drought
19	1979	1395.0	86.44	No Drought	945.0	35.03	No Drought	730.0	1.90	No Drought
20	1980	1341.0	79.22	No Drought	741.0	5.88	No Drought	646.6	-9.74	No Drought
21	1981	1178.2	57.46	No Drought	897.0	28.18	No Drought	635.5	-11.29	No Drought
22	1982	599.3	-19.90	No Drought	604.0	-13.69	No Drought	499.0	-30.34	Moderate
23	1983	832.4	11.25	No Drought	739.0	5.60	No Drought	927.0	29.40	No Drought
24	1984	581.3	-22.31	No Drought	456.0	-34.84	Moderate	380.7	-46.86	Moderate
25	1985	557.5	-25.49	No Drought	580.0	-17.12	No Drought	249.8	-65.13	Severe
26	1986	553.7	-26.00	Moderate	694.0	-0.83	No Drought	508.7	-28.99	Moderate
27	1987	836	11.73	No Drought	635.0	-9.26	No Drought	830.3	15.90	No Drought
28	1988	761.4	1.76	No Drought	803.0	14.74	No Drought	1022.3	42.70	No Drought
29	1989	972	29.91	No Drought	844.0	20.60	No Drought	863.6	20.55	No Drought
30	1990	1053.0	40.73	No Drought	726.0	3.74	No Drought	839.0	17.12	No Drought

Table 9 contd...

Table 4.9: Tahasilwise meteorological drought of Jalgaon district (1961-2016)

Sr. No.	Year	Jamner			Muktainagar			Pachora		
		Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition
31	1991	623.0	-16.74	No Drought	543.0	-22.41	No Drought	480.7	-32.90	Moderate
32	1992	852.0	13.87	No Drought	675.0	-3.55	No Drought	621.0	-13.31	No Drought
33	1993	773.1	3.32	No Drought	919.0	31.32	No Drought	741.6	3.52	No Drought
34	1994	887.4	18.60	No Drought	851.0	21.60	No Drought	402.2	-43.86	Moderate
35	1995	764.5	2.17	No Drought	719.0	2.74	No Drought	541.0	-24.48	No Drought
36	1996	596.2	-20.32	No Drought	609.0	-12.98	No Drought	879.0	22.70	No Drought
37	1997	887.2	18.57	No Drought	753.0	7.60	No Drought	799.5	11.60	No Drought
38	1998	1142.3	52.67	No Drought	955.0	36.46	No Drought	1234.3	72.30	No Drought
39	1999	695.0	-7.11	No Drought	601.0	-14.12	No Drought	553.0	-22.81	No Drought
40	2000	611.0	-18.34	No Drought	566.0	-19.12	No Drought	381.0	-46.82	Moderate
41	2001	857.0	14.54	No Drought	600.0	-14.26	No Drought	588.0	-17.92	No Drought
42	2002	770.7	3.00	No Drought	800.0	14.31	No Drought	587.2	-18.03	No Drought
43	2003	987.0	31.91	No Drought	889.0	27.03	No Drought	1016.6	41.91	No Drought
44	2004	722.0	-3.51	No Drought	657.0	-6.12	No Drought	566.0	-20.99	No Drought
45	2005	607.6	-18.80	No Drought	518.0	-25.98	Moderate	588.9	-17.80	No Drought
46	2006	1103.6	47.49	No Drought	1305.0	86.48	No Drought	984.0	37.36	No Drought
47	2007	869.2	16.17	No Drought	707.0	1.03	No Drought	582.4	-18.70	No Drought
48	2008	585.2	-21.79	No Drought	419.0	-40.13	Moderate	587.1	-18.05	No Drought
49	2009	630.2	-15.78	No Drought	654.0	-6.55	No Drought	716.6	0.03	No Drought
50	2010	559.7	-25.20	No Drought	802.0	14.60	No Drought	886.6	23.76	No Drought
51	2011	516.1	-31.02	Moderate	527.0	-24.70	No Drought	657.2	-8.26	No Drought
52	2012	363.2	-51.46	Severe	381.0	-45.56	Moderate	388.4	-45.78	Moderate
53	2013	728.5	-2.64	No Drought	850.0	21.46	No Drought	871.4	21.64	No Drought
54	2014	507.2	-32.21	Moderate	639.0	-8.69	No Drought	699.0	-2.43	No Drought
55	2015	435.9	-41.74	Moderate	585.0	-16.41	No Drought	484.5	-32.37	Moderate
56	2016	658.7	-11.97	No Drought	756.0	8.03	No Drought	707.3	-1.27	No Drought

Abstract of drought years and per cent contribution of Jamner, Mukatinagar and Pachora

Sr. No	Condition	Jamner		Muktainagar		Pachora	
		No. of Years	(%)	No. of Years	(%)	No. of Years	(%)
01	No Drought	44	79%	48	86%	44	79%
02	Moderate Drought	10	18%	8	14%	10	18%
03	Severe Drought	2	4%	0	0%	2	4%

Table 9 contd...

Table 4.9: Tahasilwise meteorological drought of Jalgaon district (1961-2016)

Sr. No.	Year	Parola			Raver			Yawal		
		Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition
1	1961	666.5	6.96	No Drought	1025.0	44.15	No Drought	692.9	1.61	No Drought
2	1962	492.2	-21.01	No Drought	679.3	-4.47	No Drought	616.0	-9.67	No Drought
3	1963	591.7	-5.04	No Drought	790.0	11.10	No Drought	665.2	-2.45	No Drought
4	1964	532.8	-14.50	No Drought	999.5	40.57	No Drought	827.2	21.30	No Drought
5	1965	418.9	-32.77	Moderate	518.2	-27.12	Moderate	440.9	-35.34	Moderate
6	1966	495.2	-20.53	No Drought	460.0	-35.31	Moderate	613.9	-9.97	No Drought
7	1967	532.6	-14.53	No Drought	852.9	19.95	No Drought	447.7	-34.35	Moderate
8	1968	316.4	-49.22	Moderate	561.7	-21.00	No Drought	748.4	9.75	No Drought
9	1969	528.7	-15.15	No Drought	617.4	-13.16	No Drought	768.0	12.62	No Drought
10	1970	659.5	5.84	No Drought	1250.0	75.79	No Drought	1005.2	47.41	No Drought
11	1971	434.0	-30.35	Moderate	452.3	-36.39	Moderate	420.4	-38.35	Moderate
12	1972	353.0	-43.35	Moderate	402.0	-43.46	Moderate	393.0	-42.37	Moderate
13	1973	470.5	-24.49	No Drought	1012.0	42.32	No Drought	360.4	-47.15	Moderate
14	1974	509.6	-18.22	No Drought	696.7	-2.02	No Drought	519.1	-23.88	No Drought
15	1975	719.9	15.53	No Drought	836.0	17.57	No Drought	536.1	-21.38	No Drought
16	1976	657.6	5.53	No Drought	947.0	33.18	No Drought	505.6	-25.86	Moderate
17	1977	390.2	-37.38	Moderate	707.0	-0.57	No Drought	487.3	-28.54	Moderate
18	1978	340.3	-45.39	Moderate	799.4	12.42	No Drought	505.8	-25.83	Moderate
19	1979	515.8	-17.22	No Drought	892.5	25.52	No Drought	792.2	16.17	No Drought
20	1980	438.6	-29.61	Moderate	622.3	-12.48	No Drought	362.8	-46.80	Moderate
21	1981	657.7	5.55	No Drought	960.4	35.07	No Drought	1056.9	54.99	No Drought
22	1982	475.2	-23.74	No Drought	559.1	-21.37	No Drought	700.9	2.78	No Drought
23	1983	1089.5	74.85	No Drought	916.1	28.84	No Drought	512.0	-24.92	No Drought
24	1984	693.1	11.23	No Drought	424.0	-40.37	Moderate	478.5	-29.83	Moderate
25	1985	571.4	-8.30	No Drought	510.0	-28.28	Moderate	509.7	-25.25	No Drought
26	1986	358.6	-42.45	Moderate	591.0	-16.88	No Drought	573.8	-15.86	No Drought
27	1987	676.8	8.61	No Drought	706.0	-0.71	No Drought	795.1	16.60	No Drought
28	1988	512.1	-17.82	No Drought	830.0	16.73	No Drought	892.6	30.90	No Drought
29	1989	470.6	-24.48	No Drought	899.1	26.45	No Drought	921.5	35.13	No Drought
30	1990	543.2	-12.83	No Drought	483.8	-31.96	Moderate	917.0	34.47	No Drought

Table 9 contd...

Table 4.9: Tahasilwise meteorological drought of Jalgaon district (1961-2016)

Sr. No.	Year	Parola			Raver			Yawal		
		Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition	Annual RF(mm)	Deviation (%)	Drought Condition
31	1991	466.5	-25.14	No Drought	483.0	-32.07	Moderate	645.0	-5.41	No Drought
32	1992	798.8	28.19	No Drought	597.0	-16.04	No Drought	641.0	-6.00	No Drought
33	1993	629.9	1.09	No Drought	1042.0	46.54	No Drought	816.0	19.66	No Drought
34	1994	755.3	21.21	No Drought	704.0	-0.99	No Drought	754.0	10.57	No Drought
35	1995	564.5	-9.41	No Drought	715.0	0.55	No Drought	736.3	7.97	No Drought
36	1996	603.1	-3.21	No Drought	614.0	-13.65	No Drought	746.0	9.40	No Drought
37	1997	695.6	11.63	No Drought	875.0	23.06	No Drought	630.0	-7.61	No Drought
38	1998	1092.8	75.38	No Drought	831.1	16.88	No Drought	1051.0	54.12	No Drought
39	1999	802.0	28.71	No Drought	726.0	2.10	No Drought	369.0	-45.89	Moderate
40	2000	513.0	-17.67	No Drought	333.0	-53.17	Severe	602.0	-11.72	No Drought
41	2001	824.6	32.33	No Drought	508.6	-28.47	Moderate	557.0	-18.32	No Drought
42	2002	691.4	10.96	No Drought	826.2	16.19	No Drought	744.8	9.22	No Drought
43	2003	1012.3	62.46	No Drought	806.3	13.39	No Drought	998.0	46.35	No Drought
44	2004	611.0	-1.95	No Drought	728.0	2.38	No Drought	694.0	1.77	No Drought
45	2005	562.1	-9.79	No Drought	449.0	-36.85	Moderate	573.0	-15.97	No Drought
46	2006	1441.6	131.35	No Drought	1232.0	73.26	No Drought	1458.4	113.87	No Drought
47	2007	756.3	21.37	No Drought	769.3	8.19	No Drought	814.5	19.44	No Drought
48	2008	573.0	-8.04	No Drought	453.3	-36.25	Moderate	458.2	-32.81	Moderate
49	2009	680.1	9.14	No Drought	614.0	-13.65	No Drought	670.0	-1.75	No Drought
50	2010	817.0	31.11	No Drought	876.2	23.22	No Drought	1057.2	55.03	No Drought
51	2011	563.9	-9.50	No Drought	510.0	-28.28	Moderate	626.6	-8.11	No Drought
52	2012	555.4	-10.87	No Drought	426.8	-39.98	Moderate	490.0	-28.14	Moderate
53	2013	1059.0	69.95	No Drought	784.5	10.33	No Drought	1016.1	49.01	No Drought
54	2014	619.0	-0.66	No Drought	639.5	-10.06	No Drought	834.4	22.36	No Drought
55	2015	436.4	-29.97	Moderate	593.3	-16.56	No Drought	476.4	-30.14	Moderate
56	2016	658.0	5.60	No Drought	681.4	-4.17	No Drought	662.4	-2.86	No Drought

Abstract of drought years and per cent contribution of Parola, Raver and Yawal

Sr. No	Condition	Parola		Raver		Yawal	
		No. of Years	(%)	No. of Years	(%)	No. of Years	(%)
01	No Drought	47	84%	42	75%	42	75%
02	Moderate Drought	9	16%	13	23%	14	25%
03	Severe Drought	0	0%	1	2%	0	0%

Table 9 contd...

Table 4.9: Tahasilwise meteorological drought of Jalgaon district (1961-2016)

Sr. No.	Year	District Average			Sr. No.	Year	District Average		
		Annual RF(mm)	Deviation (%)	Drought Condition			Annual RF(mm)	Deviation (%)	Drought Condition
1	1961	815.5	16.62	No Drought	29	1989	877.4	24.40	No Drought
2	1962	642.8	-8.44	No Drought	30	1990	839.6	19.84	No Drought
3	1963	713.5	1.80	No Drought	31	1991	567.5	-18.76	No Drought
4	1964	739.87	5.50	No Drought	32	1992	800.8	15.46	No Drought
5	1965	557.7	-20.29	No Drought	33	1993	754.8	7.94	No Drought
6	1966	587.9	-16.33	No Drought	34	1994	733.1	5.28	No Drought
7	1967	573.9	-17.72	No Drought	35	1995	621.8	-11.07	No Drought
8	1968	571.0	-18.32	No Drought	36	1996	664.1	-5.00	No Drought
9	1969	832.1	18.41	No Drought	37	1997	746.9	6.66	No Drought
10	1970	947.2	34.92	No Drought	38	1998	1024.9	46.95	No Drought
11	1971	451.7	-35.33	Moderate	39	1999	607.7	-12.76	No Drought
12	1972	434.4	-37.70	Moderate	40	2000	509.1	-27.03	No Drought
13	1973	779.9	11.07	No Drought	41	2001	654.1	-6.19	No Drought
14	1974	588.0	-15.62	No Drought	42	2002	759.4	8.64	No Drought
15	1975	853.3	22.18	No Drought	43	2003	998.3	42.90	No Drought
16	1976	751.1	8.20	No Drought	44	2004	630.8	-9.50	No Drought
17	1977	734.6	4.81	No Drought	45	2005	518.0	-25.78	No Drought
18	1978	635.3	-9.50	No Drought	46	2006	1249.9	79.69	No Drought
19	1979	812.3	15.78	No Drought	47	2007	715.2	2.63	No Drought
20	1980	667.0	-5.33	No Drought	48	2008	527.4	-24.49	No Drought
21	1981	758.4	8.31	No Drought	49	2009	709.5	1.74	No Drought
22	1982	533.6	-23.62	No Drought	50	2010	821.7	18.02	No Drought
23	1983	806.1	15.79	No Drought	51	2011	598.3	-14.36	No Drought
24	1984	534.2	-23.14	No Drought	52	2012	418.2	-39.73	Moderate
25	1985	532.9	-23.48	No Drought	53	2013	914.2	31.41	No Drought
26	1986	559.3	-20.10	No Drought	54	2014	705.5	1.22	No Drought
27	1987	752.7	7.49	No Drought	55	2015	496.8	-28.80	Moderate
28	1988	799.5	14.15	No Drought	56	2016	702.8	0.59	No Drought

Abstract of drought years and per cent contribution of Jalgaon District

District Average			
Sr. No	Condition	No. of Years	(%)
01	No Drought	42	79.2 %
02	Moderate Drought	10	19.4 %
03	Severe Drought	1	01.6 %

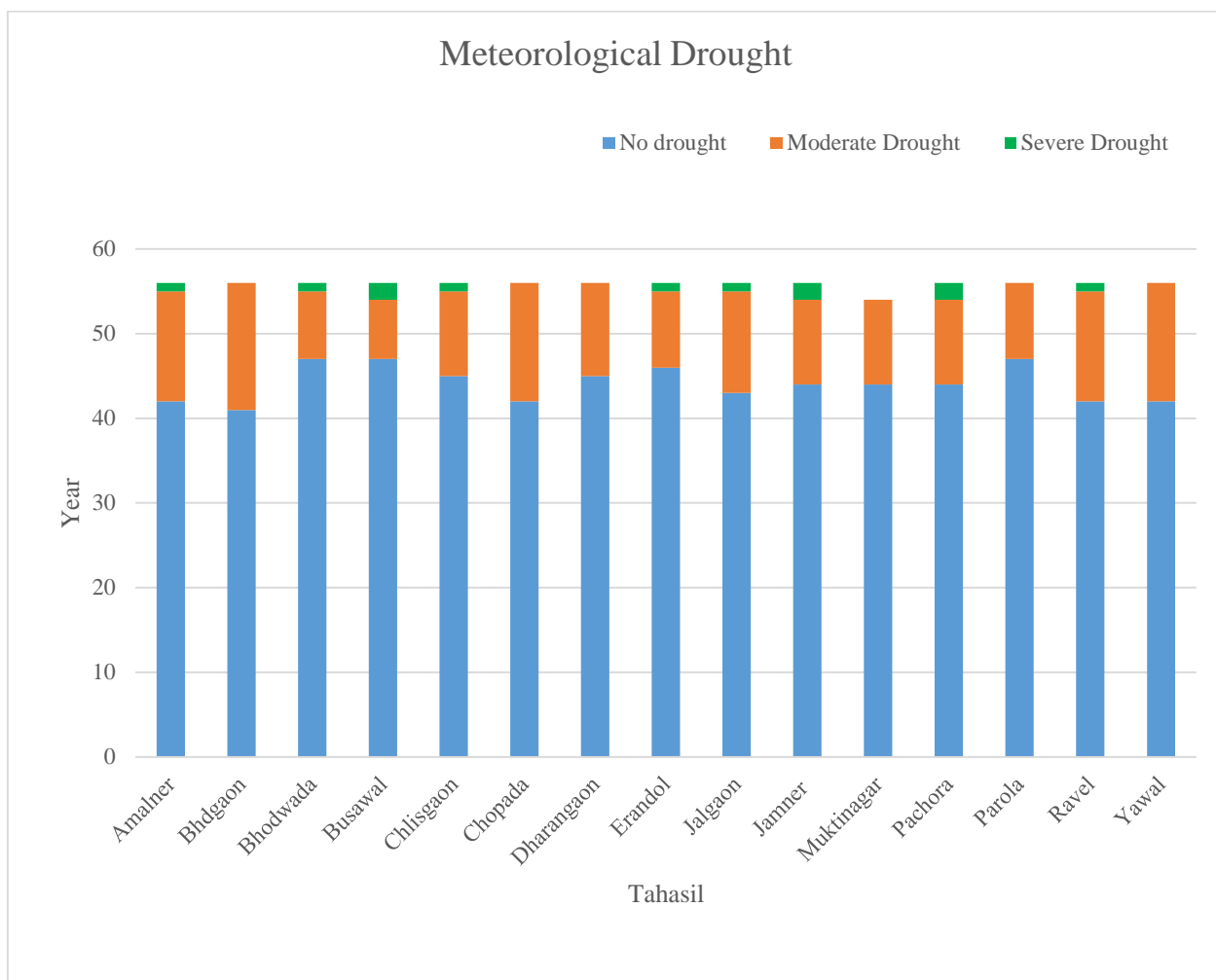


Fig. 52: Tahasilwise Meteorological Drought of Jalgaon District(1961-2016)

4.10. Onset and Withdrawl of Rainfall:

For determining onset and withdrawl of monsoon, the frequency analysis of weekly rainfall was carried out on the basis of daily data of 56 years.

The data presented in Table 10 revealed that mean start of rainy season was 24 MW in most of tahasils. However, early onset was noted at 23 MW in all the tahasils. Further, late onset was observed from 25 to 28 MW. Mean termination of rainy season was noted during 41 to 44 MW. Early termination was observed during 30 to 39 MW in all the tahasils while late termination observed during 50 to 52 MW.

Mean duration of rainy season ranged from 18 to 20 MW. Minimum duration ranged between 10 to 16 MW in the district, while maximum duration of rainy season ranged between 24 to 29 MW.

In the district the length of growing period (LGP) ranged from 90 days to 180 days. The average LGP for Amalner tahasil, was available for 77 to 189 days and the mean LGP was 129 days. Similarly, for Bhadagaon tahasil, the LGP ranged from 56 to 196 days with average of 135 days. For Bhusawal tahasil, the LGP ranged from 42 to 203 days and the average was 126 days. For Bodhwada, the LGP ranged from 70 to 203 days and the average was 132 days. For Chalisgaon tahasil, the LGP ranged from 91 to 196 days and the average was 138 days. For Chopada tahasil, the LGP ranged from 70 to 203 days and the average was 132 days. For Dharangaon tahasil, the LGP is ranged from 84 to 189 days and the average was 129 days. For Erandol, the LGP ranged from 70 to 196 days and the average LGP was 132 days. For Jalgaon, the LGP ranged from 70 to 203 days and the average was 136 days. For Jamner, the LGP ranged from 70 to 203 days and the average LGP was 129 days. For Muktainagar tahasil, the LGP ranged from 70 to 203 days and the average was 131 days. For Pachora, the LGP ranged from 70 to 203 days and the average LGP was 128 days. For Parola, the LGP ranged from 49 to 203 days and the average was 128 days. For Raver, the LGP ranged from 70 to 203 days with the average LGP of 132 days. . For Yawal, the LGP ranged from 80 to 203 days with the average LGP of 131 days. Based on the average available length of growing period, the major *kharif* crops such as sorghum, pearl millet, soybean, maize, cotton, groundnut, vegetables, pulses and fodder crops can be cultivated in all the tahasils whereas sorghum, wheat, gram, onion etc. can be grown in *rabi* season.

Similar study was carried out by Dhanawade (2016), Gangarde (2016), Patil (2017), Vende (2017), Suvarna (2017) and Powar (2017) for Solapur, Pune, Kolhapur, Ahmednagar, Satara and Sangali districts of Maharashtra, respectively.

Table 4.10: Tahasilwise onset and withdrawal of monsoon in Jalgaon district (1961-2016)

Year	Amalner					Bhadagaon					Bhodwada				
	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP
1961	25	41	16	476.3	112	25	41	16	561.5	112	26	51	25	948.9	175
1962	27	49	22	334.0	154	23	49	26	510.1	182	27	49	22	722.6	154
1963	26	47	21	610.8	147	23	47	24	1062.0	168	23	34	11	553.5	77
1964	26	38	12	379.4	84	23	49	26	1045.1	182	25	39	14	850.7	98
1965	24	48	24	541.1	168	24	50	26	596.3	182	25	50	25	588.7	175
1966	28	48	20	398.3	140	25	48	23	753.0	161	28	48	20	406.3	140
1967	25	38	13	664.2	91	24	50	26	627.1	182	25	35	10	404.0	70
1968	27	40	13	680.4	91	24	39	15	443.0	105	24	30	6	97.0	42
1969	26	45	19	808.8	133	23	37	14	1130.0	98	26	45	19	650.7	133
1970	24	40	16	600.4	112	24	39	15	932.0	105	24	41	17	774.1	119
1971	25	40	15	491.0	105	29	40	11	465.5	77	26	41	15	297.1	105
1972	26	44	18	361.5	126	26	37	11	337.3	77	26	44	18	623.8	126
1973	27	43	16	757.6	112	24	43	19	1020.8	133	23	49	26	734.6	182
1974	26	42	16	807.0	112	27	35	8	418.0	56	27	43	16	466.8	112
1975	23	44	21	1278.8	147	24	44	20	1129.8	140	23	41	18	691.9	126
1976	23	49	26	1491.0	182	23	49	26	896.0	182	23	47	24	571.0	168
1977	25	48	23	926.0	161	25	48	23	803.2	161	25	48	23	713.8	161
1978	24	48	24	534.7	168	24	49	25	372.2	175	24	37	13	616.6	91
1979	26	48	22	764.9	154	26	48	22	697.8	154	25	43	18	817.2	126
1980	23	38	15	528.4	105	23	51	28	627.7	196	23	52	29	592.7	203
1981	26	51	25	633.4	175	26	51	25	577.4	175	25	51	26	736.0	182
1982	24	45	21	481.0	147	25	45	20	441.3	140	25	45	20	618.4	140
1983	24	41	17	881.4	119	24	41	17	925.5	119	26	41	15	560.1	105
1984	23	41	18	723.8	126	26	41	15	466.6	105	23	41	18	430.2	126
1985	26	41	15	541.5	105	24	41	17	516.2	119	24	40	16	607.0	112
1986	25	52	27	348.0	189	24	52	28	483.3	196	24	39	15	683.0	105
1987	24	50	26	645.8	182	24	50	26	824.8	182	24	50	26	458.0	182

Table 10 contd...

Table 4.10: Tahasilwise onset and withdrawal of monsoon in Jalgaon district (1961-2016)

Year	Amalner					Bhadagaon					Bhodwada				
	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP
1988	24	40	16	742.6	112	24	40	16	940.2	112	24	40	16	794.6	112
1989	26	38	12	550.8	84	24	39	15	964.4	105	23	38	15	760.0	105
1990	24	50	26	797.0	182	25	49	24	773.0	168	27	41	14	677.2	98
1991	23	38	15	506.4	105	23	36	13	536.0	91	23	34	11	553.5	77
1992	23	41	18	1636.0	126	25	41	16	715.0	112	25	41	16	638.6	112
1993	27	49	22	460.6	154	24	49	25	746.0	175	24	49	25	878.3	175
1994	24	46	22	623.6	154	25	42	17	650.0	119	23	42	19	940.2	133
1995	25	42	17	348.6	119	25	42	17	520.5	119	26	42	16	597.6	112
1996	24	43	19	651.0	133	24	43	19	819.6	133	24	43	19	607.3	133
1997	24	49	25	546.8	175	24	49	25	916.0	175	24	49	25	618.2	175
1998	24	45	21	999.2	147	24	44	20	1074.9	140	24	45	21	971.2	147
1999	24	41	17	628.0	119	24	41	17	599.0	119	24	41	17	484.8	119
2000	23	38	15	262.2	105	23	35	12	440.0	84	23	37	14	689.9	98
2001	23	41	18	587.3	126	23	41	18	628.3	126	23	41	18	557.6	126
2002	25	38	13	521.0	91	26	46	20	598.1	140	26	46	20	698.2	140
2003	25	40	15	785.0	105	24	39	15	1061.0	105	24	39	15	858.9	105
2004	23	45	22	691.0	154	23	41	18	595.0	126	24	40	16	548.6	112
2005	26	39	13	373.2	91	25	42	17	632.7	119	24	42	18	512.6	126
2006	26	40	14	922.6	98	25	40	15	991.2	105	25	40	15	1394.6	105
2007	24	40	16	695.5	112	25	40	15	529.6	105	25	40	15	618.8	105
2008	24	38	14	488.3	98	24	41	17	673.0	119	27	38	11	308.2	77
2009	25	51	26	677.6	182	27	51	24	668.5	168	26	51	25	668.8	175
2010	25	47	22	660.2	154	24	47	23	752.8	161	24	47	23	809.1	161
2011	27	38	11	451.5	77	27	42	15	586.9	105	27	38	11	514.6	77
2012	27	40	13	389.9	91	26	40	14	330.8	98	27	40	13	344.5	91
2013	23	41	18	758.9	126	23	41	18	904.6	126	24	41	17	921.9	119
2014	28	50	22	627.6	154	25	50	25	603.4	175	28	50	22	653.0	154
2015	24	38	14	327.3	98	24	44	20	424.4	140	24	44	20	534.7	140
2016	25	41	16	458.2	112	22	41	19	734.0	133	25	41	16	842.5	112

Table 4.10: Tahasilwise onset and withdrawal of monsoon in Jalgaon district (1961-2016)

Year	Bhusawal					Chalisgaon					Chopada				
	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP
1961	25	41	16	914.1	112	23	50	27	810.2	189	25	41	16	871.7	112
1962	23	49	26	780.2	182	23	44	21	814.3	147	25	45	20	472.5	140
1963	24	46	22	641.3	154	23	47	24	722.7	168	23	47	24	527.0	168
1964	25	40	15	791.6	105	24	45	21	562.8	147	26	38	12	618.4	84
1965	25	36	11	579.0	77	24	50	26	636.2	182	27	46	19	453.7	133
1966	23	50	27	588.4	189	24	48	24	646.5	168	24	40	16	425.3	112
1967	24	50	26	403.8	182	25	39	14	428.3	98	26	46	20	441.0	140
1968	25	35	10	327.4	70	26	39	13	641.9	91	26	40	14	885.6	98
1969	26	45	19	818.7	133	24	37	13	1142	91	26	45	19	973.1	133
1970	24	39	15	962.0	105	24	40	16	952.5	112	24	38	14	1127.5	98
1971	24	37	13	357.7	91	25	40	15	474.0	105	23	42	19	473.0	133
1972	26	39	13	462.6	91	23	48	25	486.3	175	25	43	18	531.4	126
1973	24	40	16	779.9	112	23	44	21	698.5	147	23	39	16	750.7	112
1974	28	42	14	523.9	98	26	43	17	619.8	119	26	42	16	570.7	112
1975	24	44	20	784.8	140	24	44	20	693.0	140	24	44	20	784.9	140
1976	23	47	24	535.0	168	24	39	15	351.1	105	23	49	26	991.3	182
1977	24	48	24	813.8	168	25	40	15	619.3	105	25	49	24	639.0	168
1978	25	39	14	810.0	98	24	39	15	529.6	105	24	49	25	564.0	175
1979	25	51	26	1113.2	182	23	40	17	641.4	119	25	44	19	630.0	133
1980	23	52	29	981.9	203	25	50	25	673.3	175	23	52	29	713.0	203
1981	25	44	19	970.0	133	27	51	24	694.0	168	24	39	15	355.9	105
1982	25	45	20	615.5	140	24	45	21	520.6	147	25	45	20	440.0	140
1983	26	40	14	712.1	98	25	41	16	807.0	112	27	40	13	487.0	91
1984	23	41	18	505.8	126	23	45	22	737.0	154	27	41	14	394.0	98
1985	24	40	16	592.5	112	23	41	18	611.0	126	26	41	15	590.0	105
1986	24	39	15	680.4	105	24	52	28	685.4	196	24	52	28	567.0	196
1987	24	50	26	677.0	182	23	50	27	1025.6	189	24	50	26	855.4	182

Table 10 contd...

Table 4.10: Tahasilwise onset and withdrawl of monsoon in Jalgaon district (1961-2016)

Year	Bhusawal					Chalisgaon					Chopada				
	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP
1988	24	40	16	778.0	112	25	40	15	983.5	105	25	40	15	642.0	105
1989	25	40	15	866.0	105	23	39	16	1141.0	112	26	40	14	599.0	98
1990	24	49	25	909.8	175	26	49	23	724.0	161	23	49	26	760.0	182
1991	23	47	24	589.5	168	23	47	24	652.0	168	23	47	24	602.0	168
1992	24	41	17	759.3	119	25	41	16	676.0	112	23	41	18	844.0	126
1993	24	49	25	825.7	175	24	49	25	835.0	175	27	49	22	798.0	154
1994	24	46	22	916.3	154	24	46	22	501.0	154	23	46	23	904.0	161
1995	24	42	18	732.4	126	26	42	16	515.0	112	26	42	16	504.0	112
1996	27	43	16	601.8	112	24	46	22	849.0	154	24	43	19	605.0	133
1997	25	49	24	757.0	168	24	49	25	943.0	175	24	49	25	742.0	175
1998	24	45	21	1028.2	147	24	45	21	1091.0	147	24	45	21	999.2	147
1999	24	41	17	606.6	119	24	41	17	606.0	119	24	41	17	415.0	119
2000	23	52	29	434.0	203	23	39	16	333.4	112	23	38	15	468.2	105
2001	23	41	18	796.3	126	24	41	17	598.0	119	24	41	17	532.8	119
2002	25	42	17	648.8	119	24	46	22	885.8	154	26	36	10	844.4	70
2003	24	39	15	757.1	105	24	39	15	1137.0	105	24	39	15	1057.2	105
2004	23	46	23	792.5	161	24	46	22	468.0	154	24	40	16	550.0	112
2005	27	39	12	435.8	84	24	39	15	357.4	105	26	39	13	411.0	91
2006	25	40	15	1189	105	25	40	15	1026.0	105	25	40	15	1441.0	105
2007	24	40	16	586.3	112	24	40	16	606.6	112	25	40	15	750.0	105
2008	27	41	14	527.5	98	23	40	17	646.8	119	24	40	16	547.2	112
2009	25	46	21	765.5	147	26	51	25	724.9	175	25	46	21	861.8	147
2010	24	47	23	1054.4	161	24	47	23	793.5	161	26	47	21	962.0	147
2011	23	38	15	682.9	105	23	42	19	682.2	133	27	39	12	687.2	84
2012	27	40	13	354.1	91	24	40	16	363.0	112	27	39	12	461.9	84
2013	24	41	17	918.6	119	23	41	18	785.7	126	23	42	19	1186.8	133
2014	30	50	20	571.4	140	24	50	26	715.1	182	24	50	26	866.3	182
2015	25	44	19	430.0	133	24	47	23	458.0	161	24	38	14	430.6	98
2016	25	44	19	750.0	133	25	41	16	787.9	112	25	41	16	719.4	112

Table 4.10: Tahasilwise onset and withdrawal of monsoon in Jalgaon district (1961-2016)

Year	Dharangaon					Erandol					Jalgaon				
	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP
1961	25	41	16	914.1	112	25	41	16	913.8	112	24	51	27	860.3	189
1962	27	49	22	780.2	154	27	49	22	399.4	154	23	49	26	705.0	182
1963	26	47	21	641.3	147	23	42	19	678.2	133	23	48	25	653.5	175
1964	26	38	12	791.6	84	26	40	14	586.0	98	25	40	15	838.7	105
1965	24	48	24	579.0	168	24	50	26	492.2	182	24	50	26	557.5	182
1966	28	48	20	588.4	140	24	52	28	524.0	196	28	48	20	490.1	140
1967	25	38	13	403.8	91	24	50	26	622.0	182	24	51	27	814.5	189
1968	27	40	13	327.4	91	25	40	15	896.5	105	27	39	12	416.9	84
1969	26	45	19	818.7	133	25	39	14	546.0	98	23	45	22	894.6	154
1970	24	40	16	962.0	112	24	40	16	626.4	112	24	39	15	850.2	105
1971	25	40	15	357.7	105	25	40	15	354.0	105	25	44	19	628.6	133
1972	26	44	18	462.6	126	25	43	18	413.8	126	25	40	15	459.4	105
1973	27	43	16	779.9	112	26	44	18	680.7	126	23	43	20	799.0	140
1974	26	42	16	523.9	112	26	43	17	616.1	119	27	43	16	623.9	112
1975	23	44	21	784.8	147	24	40	16	689.4	112	24	44	20	821.0	140
1976	23	49	26	535.0	182	23	49	26	645.4	182	23	49	26	697.8	182
1977	25	48	23	813.8	161	26	48	22	590.7	154	25	48	23	797.6	161
1978	24	48	24	810.0	168	24	48	24	555.4	168	23	48	25	718.8	175
1979	26	48	22	1113.2	154	26	51	25	638.5	175	26	51	25	769.5	175
1980	23	38	15	981.9	105	24	51	27	329.9	189	23	52	29	644.4	203
1981	26	51	25	970.0	175	27	39	12	454.7	84	26	51	25	770.6	175
1982	24	45	21	615.5	147	25	45	20	251.0	140	25	45	20	614.8	140
1983	24	41	17	712.1	119	26	41	15	928.5	105	26	41	15	847.0	105
1984	23	41	18	505.8	126	27	41	14	510.0	98	23	39	16	467.2	112
1985	26	41	15	592.5	105	26	41	15	397.5	105	24	41	17	415.8	119
1986	25	52	27	680.4	189	24	52	28	524.0	196	24	39	15	417.6	105
1987	24	50	26	677.0	182	24	50	26	622.0	182	24	39	15	684.8	105

Table 10 contd...

Table 4.10 Tahasilwise onset and withdrawl of monsoon in Jalgaon district (1961-2016)

Year	Dharangaon					Erandol					Jalgaon				
	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP
1988	24	40	16	778.0	112	25	40	15	896.5	105	24	40	16	598.7	112
1989	26	38	12	866.0	84	25	39	14	546.0	98	25	50	25	1833.3	175
1990	24	50	26	909.8	182	23	50	27	1059.3	189	23	49	26	983.8	182
1991	23	38	15	589.5	105	23	39	16	749.7	112	23	52	29	502.8	203
1992	23	41	18	759.3	126	25	41	16	826.0	112	24	45	21	541.2	147
1993	27	49	22	825.7	154	25	49	24	680.0	168	24	40	16	354.9	112
1994	24	46	22	916.3	154	26	42	16	632.7	112	25	46	21	559.6	147
1995	25	42	17	732.4	119	24	42	18	471.2	126	26	42	16	484.4	112
1996	24	43	19	601.8	133	24	43	19	535.0	133	25	51	26	572.1	182
1997	24	49	25	757.0	175	24	49	25	793.0	175	24	45	21	375.9	147
1998	24	44	20	995.2	140	24	44	20	1011.4	140	24	45	21	792.0	147
1999	28	45	17	597.5	119	25	41	16	692.1	112	24	41	17	606.6	119
2000	23	36	13	404.0	91	23	39	16	435.6	112	23	36	13	707.8	91
2001	23	41	18	598.0	126	23	41	18	687.0	126	23	42	19	752.2	133
2002	26	41	15	585.5	105	26	36	10	787.2	70	26	41	15	903.3	105
2003	25	39	14	900.0	98	25	39	14	923.0	98	24	39	15	1191.2	105
2004	24	40	16	604.0	112	23	40	17	528.0	119	24	40	16	489.1	112
2005	25	39	14	568.8	98	26	39	13	492.0	91	26	39	13	476.1	91
2006	25	40	15	1410.4	105	25	40	15	1277.1	105	25	40	15	1422.9	105
2007	24	40	16	757.1	112	24	40	16	720.0	112	25	40	15	737.8	105
2008	23	41	18	549.0	126	23	41	18	663.0	126	24	40	16	398.7	112
2009	25	51	26	752.0	182	26	51	25	841.0	175	27	51	24	725.1	168
2010	25	47	22	750.5	154	24	47	23	854.5	161	24	47	23	719.5	161
2011	25	37	12	554.0	84	23	40	17	678.0	119	23	38	15	728.0	105
2012	26	40	14	332.7	98	24	40	16	468.0	112	27	37	10	298.0	70
2013	23	42	19	1023.8	133	23	43	20	909.7	140	24	42	18	943.2	126
2014	28	50	22	844.8	154	27	50	23	841.5	161	28	50	22	773.0	154
2015	24	38	14	403.2	98	24	44	20	451.0	140	24	38	14	376.6	98
2016	25	40	15	611.5	105	23	40	14	768.4	98	25	41	16	747.0	112

Table 4.10: Tahasilwise onset and withdrawal of monsoon in Jalgaon district (1961-2016)

Year	Jamner					Muktainagar					Pachora				
	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP
1961	25	41	16	761.9	112	24	41	17	973.0	119	23	51	28	651.4	196
1962	23	49	26	780.7	182	23	52	29	734.0	203	23	49	26	720.9	182
1963	24	46	22	690.1	154	23	48	25	667.0	175	23	48	25	978.6	175
1964	25	40	15	719.7	105	25	40	15	883.0	105	25	40	15	797.9	105
1965	25	36	11	496.7	77	23	39	16	572.0	112	25	50	25	636.4	175
1966	23	50	27	765.4	189	25	41	16	486.0	112	24	48	24	1062.6	168
1967	24	50	26	330.2	182	24	49	25	566.0	175	24	51	27	685.0	189
1968	25	35	10	369.6	70	24	42	18	351.0	126	25	40	15	735.2	105
1969	26	45	19	964.7	133	23	45	22	705.0	154	26	45	19	1055.2	133
1970	24	39	15	1071.9	105	23	40	17	1020.0	119	24	40	16	1070.1	112
1971	24	37	13	383.2	91	25	41	16	380.0	112	26	48	22	514.1	154
1972	26	39	13	256.0	91	26	37	11	498.0	77	23	41	18	354.2	126
1973	24	40	16	774.8	112	23	49	26	847.0	182	23	49	26	1113.8	182
1974	28	42	14	502.7	98	27	41	14	576.0	98	25	49	24	330.9	168
1975	24	44	20	817.9	140	25	44	19	779.0	133	24	39	15	1026.5	105
1976	23	47	24	496.0	168	23	49	26	686.0	182	23	49	26	655.5	182
1977	24	48	24	822.8	168	25	48	23	760.0	161	25	48	23	894.0	161
1978	25	39	14	927.2	98	24	49	25	763.0	175	24	49	25	498.0	175
1979	25	51	26	1373.7	182	25	48	23	945.0	161	25	47	22	704.0	154
1980	23	52	29	1282	203	23	52	29	741.0	203	23	52	29	622.6	203
1981	25	44	19	1174.3	133	26	52	26	897.0	182	25	51	26	611.5	182
1982	25	45	20	573.3	140	25	45	20	604.0	140	25	45	20	494.0	140
1983	26	40	14	810.3	98	25	41	16	739.0	112	24	41	17	927.0	119
1984	23	41	18	571.2	126	26	41	15	456.0	105	27	41	14	351.7	98
1985	24	40	16	537.8	112	23	41	18	580.0	126	26	41	15	205.7	105
1986	24	39	15	528.0	105	24	39	15	694.0	105	25	38	13	501.3	91
1987	24	50	26	710.1	182	24	50	26	635.0	182	24	50	26	791.0	182

Table 10 contd...

Table 4.10: Tahasilwise onset and withdrawal of monsoon in Jalgaon district (1961-2016)

Year	Jamner					Muktainagar					Pachora				
	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP
1988	24	40	16	753.3	112	25	40	15	803.0	105	24	40	16	1011.6	112
1989	25	40	15	877.2	105	24	40	16	844.0	112	23	39	16	808.6	112
1990	24	49	25	914.0	175	24	43	19	726.0	133	27	44	17	797.0	119
1991	23	47	24	623.0	168	23	39	16	543.0	112	23	36	13	480.5	91
1992	24	41	17	834.0	119	25	41	16	675.0	112	25	41	16	598.7	112
1993	24	49	25	748.1	175	24	49	25	919.0	175	26	49	23	712.4	161
1994	24	46	22	862.4	154	23	46	23	851.0	161	24	46	22	399.2	154
1995	24	42	18	661.3	126	26	42	16	719.0	112	26	42	16	497.5	112
1996	27	43	16	584.2	112	24	43	19	609.	133	24	43	19	879.0	133
1997	25	49	24	869.2	168	26	49	23	753.	161	25	49	24	720.5	168
1998	24	45	21	1142.3	147	24	45	21	1069.8	147	24	45	21	1234.3	147
1999	25	41	16	600.0	112	23	41	18	597.5	126	24	41	17	513.0	119
2000	23	39	16	592.0	112	23	35	12	451.9	84	23	39	16	379.0	112
2001	24	41	17	798.0	119	23	41	18	568.0	126	24	41	17	535.0	119
2002	26	46	20	770.7	140	26	46	20	853.5	140	26	46	20	568.8	140
2003	25	39	14	971.0	98	24	39	15	700.0	105	24	52	28	979.6	196
2004	23	39	16	721.0	112	24	41	17	671.0	119	24	46	22	511.0	154
2005	25	38	13	572.6	91	26	39	13	465.0	91	27	38	11	546.6	77
2006	25	40	15	1044.6	105	25	40	15	1274.0	105	25	40	15	925.0	105
2007	24	40	16	869.2	112	26	40	14	586.7	98	25	40	15	579.4	105
2008	24	41	17	560.2	119	27	41	14	444.3	98	26	41	15	560.1	105
2009	26	51	25	605.2	175	26	51	25	747.6	175	26	51	25	693.4	175
2010	24	47	23	554.0	161	24	47	23	993.8	161	24	47	23	872.4	161
2011	26	38	12	481.8	84	27	37	10	555.0	70	23	42	19	645.7	133
2012	26	40	14	347.2	98	27	40	13	351.2	91	26	40	14	345.4	98
2013	23	41	18	722.2	126	24	41	17	723.0	119	23	41	18	856.3	126
2014	29	50	21	473.2	147	29	50	21	393.2	147	28	50	22	645.2	154
2015	24	38	14	391.9	98	25	38	13	364.2	91	24	38	14	406.3	98
2016	25	41	16	658.7	112	25	41	16	756.0	112	22	40	18	707.3	126

Table 4.10: Tahasilwise onset and withdrawal of monsoon in Jalgaon district (1961-2016)

Year	Parola					Raver					Yawal				
	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP
1961	23	41	18	663.6	126	24	41	17	1015.7	119	25	51	26	692.9	182
1962	27	45	18	469.6	126	23	52	29	679.3	203	23	49	26	576.0	182
1963	24	51	27	582.7	189	23	48	25	716.6	175	23	48	25	650.5	175
1964	26	38	12	516.2	84	25	40	15	966.0	105	25	40	15	822.7	105
1965	24	50	26	385.7	182	23	39	16	518.2	112	27	50	23	403.6	161
1966	24	39	15	493.0	105	25	41	16	460.0	112	28	48	20	608.9	140
1967	23	38	15	532.6	105	24	49	25	842.9	175	24	40	16	447.0	112
1968	27	34	7	266.8	49	24	42	18	545.2	126	26	40	14	715.4	98
1969	24	37	13	526.7	91	23	45	22	606.0	154	25	45	20	750.0	140
1970	23	41	18	583.9	126	23	40	17	1095.0	119	24	39	15	850.5	105
1971	23	40	17	408.4	119	25	41	16	408.5	112	23	40	17	408.9	119
1972	26	44	18	331.0	126	26	37	11	384.2	77	23	39	16	388.0	112
1973	27	41	14	436.8	98	23	49	26	982.0	182	24	41	17	355.4	119
1974	26	41	15	494.6	105	27	41	14	611.0	98	26	49	23	489.2	161
1975	23	40	17	671.9	119	25	44	19	791.0	133	25	42	17	474.2	119
1976	23	47	24	652.6	168	23	49	26	947.0	182	26	42	16	396.6	112
1977	25	48	23	361.2	161	25	48	23	674.0	161	24	43	19	461.0	133
1978	25	48	23	276.3	161	24	49	25	733.4	175	25	49	24	496.8	168
1979	26	48	22	491.5	154	25	48	23	799.0	161	25	45	20	762.3	140
1980	23	52	29	438.6	203	23	52	29	622.3	203	24	41	17	337.2	119
1981	25	51	26	647.7	182	26	52	26	920.7	182	26	51	25	1027.8	175
1982	25	45	20	413.2	140	25	45	20	548.1	140	25	43	18	700.9	126
1983	25	41	16	1054.6	112	25	41	16	899.6	112	26	41	15	484.2	105
1984	24	41	17	676.1	119	26	41	15	397.0	105	23	41	18	478.5	126
1985	23	41	18	536.4	126	23	41	18	508.0	126	24	41	17	466.7	119
1986	26	38	12	330.6	84	24	39	15	585.0	105	25	52	27	527.8	189
1987	24	50	26	620.8	182	24	50	26	687.0	182	24	50	26	714.1	182

Table 10 contd...

Table 4.10: Tahasilwise onset and withdrawal of monsoon in Jalgaon district (1961-2016)

Year	Parola					Raver					Yawal				
	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP	Start	End	Duration	Rainfall	LGP
1988	25	40	15	490.1	105	25	40	15	789.0	105	24	40	16	892.6	112
1989	26	39	13	435.6	91	24	40	16	799.1	112	25	39	14	897.5	98
1990	24	50	26	540.2	182	24	43	19	468.8	133	25	43	18	888.0	126
1991	23	38	15	450.5	105	23	39	16	483.0	112	23	39	16	640.0	112
1992	25	41	16	797.8	112	25	41	16	597.0	112	24	41	17	636.0	119
1993	25	49	24	608.9	168	24	49	25	1030.0	175	27	49	22	758.0	154
1994	24	46	22	741.3	154	23	46	23	704.0	161	23	42	19	717.0	133
1995	26	42	16	470.3	112	26	42	16	685.0	112	26	42	16	603.3	112
1996	27	45	18	580.5	126	24	43	19	614.0	133	24	43	19	731.0	133
1997	24	51	27	686.6	189	26	49	23	849.0	161	25	49	24	621.0	168
1998	26	42	16	1077.0	112	24	45	21	831.1	147	24	45	21	1051.0	147
1999	24	41	17	779.0	119	24	41	17	667.0	119	24	41	17	356.0	119
2000	23	39	16	487.0	112	23	33	10	329.0	70	23	52	29	587.0	203
2001	23	41	18	814.6	126	23	41	18	491.6	126	23	41	18	555.0	126
2002	25	46	21	665.7	147	26	45	19	802.2	133	26	46	20	677.8	140
2003	25	39	14	900.9	98	24	39	15	796.3	105	24	39	15	951.0	105
2004	23	45	22	547.0	154	24	40	16	709.0	112	24	40	16	630.0	112
2005	26	39	13	517.4	91	27	42	15	400.0	105	24	39	15	534.0	105
2006	25	40	15	1412.2	105	25	40	15	1205.0	105	25	40	15	1432.4	105
2007	24	40	16	754.1	112	26	40	14	748.3	98	25	40	15	798.5	105
2008	23	38	15	573	105	27	41	14	426.4	98	27	39	12	431.5	84
2009	25	51	26	680.1	182	26	51	25	594.4	175	26	51	25	648.8	175
2010	25	47	22	791.3	154	24	47	23	876.2	161	25	47	22	1009.2	154
2011	27	39	12	544.2	84	27	39	12	498.6	84	27	39	12	618.4	84
2012	26	40	14	534.0	98	27	40	13	400.4	91	27	39	12	464.8	84
2013	23	42	19	1055.4	133	24	42	18	751.1	126	23	42	19	1014.8	133
2014	25	46	21	546.6	147	28	50	22	611.4	154	28	50	22	801.7	154
2015	24	38	14	394.9	98	25	38	13	467.2	91	24	38	14	425.1	98
2016	25	41	16	658.0	112	25	41	16	681.4	112	25	41	16	662.4	112

5. SUMMARY AND CONCLUSIONS

5.1. Summary:

The study was carried out at Department of Agricultural Meteorology, College of Agriculture, Pune, during 2017-2018. The data was collected for each tahasil of Jalgaon district for the period of 56 years (1961-2016) from India Meteorological Department, Pune, Department of Agriculture, Pune, Zonal Agricultural Research Station, Solapur and Department of Agricultural Meteorology, College of Agriculture, Pune.

The daily data was converted into total and mean weekly, monthly, seasonal and annual rainfall basis. The extreme lowest and highest rainfall, mean, starting, ending, duration of rainy season and length of growing period (LGP), starting and ending of rainy season were estimated by forward and backward accumulation, from the Weather Cock, computerized programme developed by CRIDA, Hyderabad.

By considering the overall situation of the onset and withdrawal of monsoon, assured rainfall and drought conditions, the cropping pattern was suggested for Jalgaon district at tahasil level. The average annual rainfall was 698.9 mm. It varied from 623.1 mm at Parola to 748.2 mm at Jamner. The average annual rainfall of Jalgaon district was received in 43 days with the highest of 61 rainy days during 2016 and the lowest of 25 rainy days during 2000.

Out of total annual rainfall, South-West monsoon alone contributed to 87.64 per cent rainfall, while remaining seasons contributed to North-East (9.88 per cent), summer (1.64 per cent) and winter (0.82 per cent) seasons.

Among the total annual rainfall SW (June to September) monsoon recorded higher rainfall than remaining months. This rainfall coincides with reproductive stage of *kharif* crop as well as timely sowing of *rabi* crops. The average monthly rainfall variation was in the range of 27.27 per cent to 3.0 per cent in July and March months respectively. The average highest monthly rainfall of 165.3 mm was noted during July which contributed to 48.20 per cent of total rainfall in a year and was followed by August receiving 165.0 mm with 57.47 per cent contribution.

The highest average weekly rainfall received was 53.1 mm in 32 MW with 114.2 per cent variation and lowest rainfall received is 0.0 mm in 4, 14 and 17 MW with no variation. Less variation was observed from 23 to 41 MW.

The average number of drought years of district for no drought, moderate drought and severe drought were 42 years, 10 years and 1 years with contribution of 79, 19 and 2 per cent, respectively.

Onset of monsoon in Jalgaon district was ranged between 23 to 28^{MW} while withdrawal of monsoon was noted from 41 to 52 MW.

It was clear that maximum rainfall received from 30 to 40 MW. This indicated that there was sufficient moisture for growing *kharif* crops as well as *rabi* crops in these tahasils. However, some short duration and medium duration crops should be grown on stored soil moisture in this region. Also, for most of the crops provision of supplementary irrigation is needed.

5.2. Conclusions:

The assured rainfall was observed from June to September month. Onset and withdrawal of monsoon indicated that Jalgaon district at tahasil level was *kharif* dominated. Average of severe drought for all the tahasils of Jalgaon district was about one years, moderate drought was observed for ten years. Contingency crop planning is suggested according to severity of drought. Appropriate prolific measures are suggested.

Cropping Pattern Suggested:

Based on the analysis of rainfall, suitable cropping pattern are suggested for effective utilization of soil moisture nutrients with minimum loss of soil for sustainable crop production and to raise the economic condition of the farmers.

- *Kharif* crops viz. sorghum, cotton, pearl millet, maize, pulses like redgram, greengram, maize, niger, groundnut and in *rabi* season wheat, gram, safflower, sorghum should be predominantly cultivated in this zone.
- Horticultural crops viz. carrot, cabbage, brinjal, okra, onion, sweet potato, tomato, chili, banana, acid lime, sweet orange in irrigated areas while, custard apple, tagets, aster be grown under assured rainfall conditions.
- Present cropping system of the field crops and fruit crops should be continued.
- It is suggested to grow improved varieties of crops.
- There is also some scope to grow vegetables, flowers and fruit crops for remunerative purpose.
- There is also greater scope for incorporation of goat and milch animals for remunerative purpose

Table 5.1: Tahasilwise cropping pattern suggested based on rainfall characterization

Sr. No	Tahasil	Existing cropping pattern			Suggested cropping pattern		
		<i>Kharif</i>	<i>Rabi</i>	Horticulture crops	<i>Kharif</i>	<i>Rabi</i>	Horticulture crops
1	Amalner	Sorghum, pearl millet, cotton	Wheat, sorghum, gram	Banana, sweet lime and guava	Sorghum, pearl millet, red gram, groundnut, green gram, cotton, sugarcane, maize, soybean, sesamum	Wheat, sorghum, gram, maize, safflower	Carrot, cabbage, brinjal, okra, onion, tomato, banana, tagets, aster
2	Bhadagaon	Paddy, green gram, cotton, pearl millet	Wheat, sorghum, gram	Mango, banana	Paddy, pearl millet, green gram, red gram, maize, sesamum, niger	Wheat, sorghum, gram, maize, green grass, elephant grass	Tomato, potato, brinjal, okra, onion, tagets, aster tamarind, aonla, ber
3	Bhusawal	Sorghum, pearl millet, cotton	Wheat, gram	Banana, guava	Pearl millet, niger, cotton, maize, green gram, groundnut, sunflower, sesamum	Sorghum, wheat, gram, maize, safflower	Custradapple, sweetpotato, brinjal, okra, chilli
4	Bodhwada	Sorghum, cotton, pearl millet	Wheat, gram	Sweet lime, banana	Pearl millet, maize, cotton, groundnut, safflower, sesamum	Wheat, gram, sorghum, maize	Sweetpotato, brinjal, onion, chilli, okra
5	Chalisgaon	Sorghum, cotton, pearl millet	Wheat, gram	Banana, grapes, guava	Sorghum, pearl millet, cotton, groundnut, red gram, sugarcane, maize, sunflower, sesamum	Wheat, gram, maize	Onion, aster, carrot, Ber
6	Chopada	Sorghum, cotton, pearl millet	Wheat, gram	Acid lime, banana	Sorghum, pearl millet, groundnut, sesamum, sugarcane, maize, cotton green gram,	Wheat, gram, maize, safflower	Onion, aster, chilli
7	Dharangaon	Sorghum, cotton, pearl millet	Wheat, gram	Mango, banana	Pearl millet, groundnut, cotton, maize, green gram	Sorghum, wheat, gram, maize, safflower	Onion, chilli, custard apple

Table 11 contd...

Table 5.1: Tahasilwise cropping pattern suggested based on rainfall characterization

Sr. No	Tahasil	Exiting cropping pattern			Suggested cropping pattern		
		<i>Kharif</i>	<i>Rabi</i>	Horticulture crops	<i>Kharif</i>	<i>Rabi</i>	Horticulture crops
8	Erاندول	Sorghum, pearl millet, cotton	Wheat, gram	Sweet orange, banana, acid lime	Pearl millet, groundnut, sesamum, cotton, maize, greengram, niger	Sorghum, wheat, gram, maize,	Onion, chilli, custard apple, banana
9	Jalgaon	Sorghum, cotton, pearl millet	Wheat, gram	Acid lime, banana	Pearl millet, sesamum, maize, cotton, groundnut, redgram, sugarcane	Sorghum, wheat, gram, maize	Onion, aster, chilli, banana
10	Jamner	Sorghum, cotton, pearl millet	Wheat, gram	Banana, sweet orange	Sorghum, pearl millet, cotton, groundnut, redgram, greengram, sugarcane, maize	Wheat, gram, maize, green grass, elephant grass	Onion, aster, chilli, banana
11	Muktainagar	Sorghum, pearl millet, soyabean	Wheat, sorghum, gram	Banana, guava	Sorghum, pearl millet, cotton, groundnut, redgram, greengram, soybean, niger, sugarcane	Wheat, sorghum, gram, maize	Carrot, cabbage, brinjal, okra, onion, tomato, potato, chilli, banana, tagetes, aster
12	Pachora	Sorghum, cotton, pearl millet	Wheat, gram	Mango, banana, , sweet orange	Pearl millet, cotton, groundnut, greengram, sugarcane, maize, sesamum	Sorghum, wheat, gram, maize,	Onion, chilli, banana, Ber
13	Parola	Sorghum, cotton, pearl millet	Wheat, gram	Sweet orange, banana, grapes	Pearl millet, groundnut, sunflower, sesamum, cotton, maize, greengram	Sorghum, wheat, gram, maize, safflower	Onion, chilli, tomato, brinjal, cabbage, okra, sweetpotato, custard apple, banana
14	Raver	Sorghum, cotton, pearl millet	Wheat, gram	Banana, , sweet orange	Sorghum, pearl millet, cotton, groundnut, redgram, greengram, sugarcane, maize	Wheat, gram, maize	Onion, chilli, banana, Ber
15	Yawal	Cotton, blackgram	Wheat, gram	Sweet orange, banana, acid lime	Pearl millet, maize, cotton, groundnut, safflower, sesamum	Wheat, sorghum, gram, maize, safflower	Custard apple, sweetpotato, brinjal, okra, chilli

Table 5.2: Cropping pattern suggested according to soil type

Sr. No.	Soil type	Tahasil	Suggested crops
1	Deep black	On junction of Amalner, Chopada, Yawal, Jalgaon, and Bhusawal tahasil.	<i>Bt.</i> cotton, maize, niger, sorghum- <i>rabi</i> , wheat, gram, onion, chilli, okra, sweetpotato, custard apple, tagets, aster
2	Medium black	Amalner, Bhadagaon, Bodhwada, Chalisgaon, Dharangaon, Erandol, Jalgaon, Jamner, Muktainagar, Pachora and Parola.	Deshi cotton, sorghum, black gram, green gram, red gram, sesamum, groundnut, soyabean, wheat, tomato, potato, brinjal, okra, onion, banana
3	Shallow	North side of Chopada, Yawal, Raver and Muktainagar tahasil	Pearl millet, mothbean, tamarind, aonla, ber

Table 5.3: Cropping pattern suggested according to crop water requirement

Sr. No.	Name of the crop	Water requirement (mm)	Suggested crops
<i>Kharif</i>			
1	Cotton	700-1300 mm	Groundnut, soybean, cotton, niger, sesamum, sunflower, safflower
2	Pearl millet	400 mm	Pearl millet, greengram, redgram, niger, sesamum
<i>Rabi</i>			
3	Wheat	550 mm	Wheat, gram, maize, soybean
4	Gram	450-650 mm	Sorghum, gram, wheat, maize
Horticulture crops			
5	Banana	1000-1200 mm	Mango, pomegranate, aster, sweet lime, guava, custard apple, carrot, cabbage, onion, chilli, tomato, sweet potato, brinjal, okra
6	Acid lime	900-1200 mm	Banana, mango, sweet lime, custardapple, pomegranate, guava, cabbage, tomato, brinjal,

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7. APPENDIX

Standard Meteorological Weeks

MW	Calendar Month	Date (From - To)	MW	Calendar Month	Date (From - To)
1	January	01-07	27	July	02-08
2	"	08-14	28	"	09-15
4	"	15-21	29	"	16-22
3	"	22-28	30	"	23-29
5	"	29-04	31	"	30-05 Aug.
6	February	05-11 Feb.	32	August	06-12
7	"	12-18	33	"	13-19
8	"	19-25	34	"	20-26
9*	"	26-04 March	35	"	27-02
10	March	05-11	36	September	03-09 Sept.
11	"	12-18	37	"	10-16
12	"	19-25	38	"	17-23
13	"	26-01 April	39	"	24-30
14	April	02-08	40	October	01-07
15	"	09-15	41	"	08-14
16	"	16-22	42	"	15-21
17	"	23-29	43	"	22-28
18	"	30-06 May	44	"	29-04
19	May	07-13	45	November	05-11 Nov.
20	"	14-20	46	"	12-18
21	"	21-17	47	"	19-25
22	"	28-03 June	48	"	26-02 Dec.
23	June	04-10	49	December	03-09
24	"	11-17	50	"	10-16
25	"	18-24	51	"	17-23
26	"	25-01 July	52**	"	24-31

*MW No. 9 is 8 days in leap year.

**MW No. 52 is of 8 days.

VITAE

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