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Rainfall analysis based rice crop planning in Durg district of Chhattisgarh

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ABSTRACT

Daily rainfall data for 20 years (1994-2013) were 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 *etc.* 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. Analysis revealed that mean annual rainfall for the three study Blocks was found to be 1067.9, 908.7 and 1088.8 mm, respectively and 98% amount of the total annual rainfall occurred during monsoon season itself. Out of 20 years, 20, 11 and 25% years were observed as excess rainfall years; 25, 23 and 28% as normal rainfall years and rest 55, 66 and 50% as deficit rainfall years at Durg, Dhamdha and Patan Blocks, respectively. It indicates that larger rainfall deficiency is observed at Dhamdha Block as compared to other Blocks. Probability analysis of weekly and seasonal rainfall showed that weekly rainfall for 23-28 SMWs and 37-43 SMWs followed exponential distribution and it followed normal distribution for 29-36 SMWs, while the seasonal rainfall followed normal distribution only at all the three selected Blocks, based on Chi-square test of goodness of fit. The seasonal rainfall amounts at 75% probability levels were observed to be 743, 730 and 881 mm in Durg, Dhamdha and Patan Blocks, respectively. The expected ET demand of rice crop at the three Blocks was found to be 738 mm for medium duration rice variety. Considering the whole crop duration, it seems that seasonal rainfall meets the ET demands. However, the distribution of probable weekly rainfall was found to be quite erratic. The expected rainwater received at 75% probability is less as compared to ET demands at nursery stage of the rice crop. The expected weekly rainfall amounts at seedling and vegetative stages are reasonably in surplus as compared to ET demand. Therefore, this surplus rainwater needs to be harvested at the farm itself for recycling during rainfall deficit period of reproductive stage. Because, during reproductive stage (35-40 SMW), the total ET demand was found to be 195.1 mm whereas the expected rainwater availability at 75% probability during this period was only 73.2, 56.7 and 65.0 mm at Durg, Dhamdha and Patan Blocks, respectively, which indicates 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.

1. INTRODUCTION

Rainfall is one of the most important natural resource inputs to crop production in the tropical region. Out of 189.54 m ha (1996-97), gross cropped area (including area sown more than once) of the country, 61.3% (116.26 m ha) falls under rainfed farming. In India, the gross irrigated area has been rapidly increasing from 28 m ha in 1960-61 to 72.8 m ha in 1997-98. Despite this progress, marginal and small farmers constituting 80% of agricultural income group, still depend on rainfed farming (Bhakhar *et al., 2008)*. The early or delayed in onset of monsoon, early or late withdrawal of monsoon, breaks in monsoon period, unusual heavy or no rainfall during the critical pheno-phases of crop may disturb the normal crop growth and development. To exploit the available rainfall effectively, crop planning and management practices must be followed based on the rainfall amount and its distribution at a given place. The excess rainfall may alsobe stored in water harvesting structures to recycle the water during critical stages of the crop. Sharma and Dubey (2013) also emphasized the need for rainwater harvesting in their study in Uttar Pradesh to mitigate the terminal droughts of crops.

The state of Chhattisgarh receives an average annual rainfall of about 1200 mm which is quite enough for successful rice crop production in *kharif* season. Though, average annual rainfall seems to be good enough for raising rice crop but its distribution is not uniform during entire crop growth period, especially during critical growth stages (flowering and reproductive phases). Thus, terminal droughts are likely to occur more often. The success or failure of rainfed rice crop is ultimately dependent on the rainfall conditions, which are not in one's control. It is, however, possible to get higher crop production by adjusting crop plans, agronomic practices and land-water management options according to probable rainfall availability and crop-water demands. The quantity of rainfall received over a period of time at any location provides a general picture of its sufficiency or inadequacy to meet crop demands. Analysis of monthly rainfall data is not usually considered appropriate from crop planning point of view. Thus, it has been suggested to consider the week as the unit of time in the tropics, where the rainfall is showery and highly freakish in intensity, amount and distribution.

The concept of estimating probabilities with respect to a given amount of rainfall is extremely helpful for crop and water resources planning. Probability analysis can be used to forecast the occurrence of future rainfalls based on historical rainfall record (Kumar and Kumar, 1989). Probability analysis of rainfall for crop and water resources planning has been attempted for different places in India (Singh *et al*., 2012; Sharma and Singh, 2010; Kumar *et al*., 2007; Sharda and Bhushan, 1985; Agrawal *et al*., 1988; Mohanty *et al*., 1999; Rizvi *et al*., 2001; Singh, 2001; Bhakhar *et al*., 2006). In a growing season of a given crop, decisions should be taken many times based on the probability of receiving certain amount of rainfall and ET demands of the given crop during a given period. The present analysis, therefore, was taken up to assess the expected weekly rainfall amounts at different probability levels of exceedance and comparing the rainfall availability with the evapotranspiration demands of rice crop for three Blocks of Durg district in Chhattisgarh under rainfed farming situation.

2. MATERIALS AND METHODS

Study Area

The three Blocks, namely Durg, Dhamdha and Patan of Durg district in Chhattisgarh were selected for the present study. These Blocks represent Chhattisgarh agro-climatic zone of the state as per the classification of National Agricultural Research Project (NARP). The area of study is geographically located at $81^0$24'E longitudes, $21^0$19'N latitude and at an altitude of 317 m above msl (Fig. 1). These study blocks have a total geographical area of about 2238 sq km. The whole study area falls in tropical zone of Indian subcontinent. Rainy season begins from middle of June and starts terminating by the end of September. Summer season is hot reaching a peak temperature of 45^0C in second fortnight of May. The month of December in winter usually experiences a minimum temperature of 7-8^0C. The relative humidity is as low as 19% in summer and goes up to 80% during monsoon period. The winds blow with moderate speed of about 5-6 km hr^{-1}. The mean monthly values of meteorological parameters are given in Table 1. The characteristic toposequence is *kanhar* (vertisols), which is found in the lowest land portion, whereas *dorsa* (alfisols) is situated just upstream of *kanhar* soil and *matasi* (inceptisols) is found just upstream side of *dorsa* soils and finally *bhata* (entisols) encounters at the top of the toposequence. The largest cultivated area in Durg district is occupied by *matasi* soils. Rice is the main *kharif* crop that covers 80-90% of total cultivated area in monsoon season. Farmers of this area generally grow long and medium duration photosensitive tall rice varieties, which flower by mid to late September and mature by mid to late November depending upon the duration of the rice varieties grown.

Mean Rainwater Availability

Daily rainfall data were collected for a period of 20 years (1994-2013) from three Blocks namely, Durg, Dhamdha and Patan of Durg district for working out weekly,

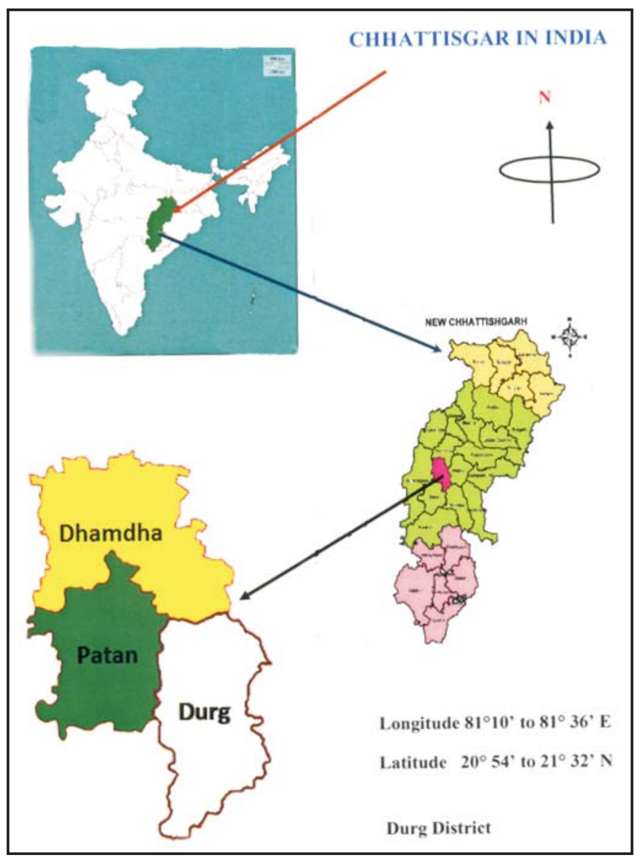

Fig.1. Geographic location map of the study area

Table: 1
Mean monthly value of climatic parameters

Month	Max. Temp. (^{0}C)	Min. Temp. (^{0}C)	RH (%)	Wind Speed (km hr^{-1})	Sunshine (hr)	Evaporation (mm)
January	28.3	17.3	38.3	2.8	8.3	2.8
February	30.5	19.7	32.8	3.6	8.9	4.1
March	36.2	24.6	24.2	4.5	8.2	5.9
April	39.6	28.6	18.6	6.4	8.2	8.9
May	43.3	32.8	20.6	8.4	8.7	11.0
June	36.9	29.8	46.6	10.9	1.6	7.8
July	32.2	27.6	74.5	10.7	2.8	3.8
August	31.0	27.1	79.7	8.9	3.0	3.1
September	31.0	26.4	71.4	5.5	5.4	3.3
October	32.0	25.00	56.9	3.3	8.3	3.4
November	29.4	19.7	39.3	2.6	8.3	2.8
December	28.5	17.1	36.0	2.3	8.2	2.6

seasonal and annual rainwater availability. The mean values of weekly, seasonal and annual rainfall for all the locks were worked out for use in the analysis (Table 2). By using mean annual rainfall values and standard deviation, the excess, normal and deficit rainfall years were identified. If rainfall in an individual year is equal to or more than the mean annual rainfall plus one standard deviation, the year is considered as excess rainfall year. Similarly, the years that receive less than the mean annual rainfall are taken as deficit years and the years that receive annual rainfall approximately equal to the mean annual rainfall are considered as normal years.

Probable Rainwater Availability

The weekly rainfall data were subjected to probability analysis by fitting normal and exponential distribution based on Chi-square test of goodness of fit, which is expressed as the following equation:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i} \quad ...(1)$$

Where, O_i is the observed frequency and E_i is the expected frequency of rainfall.

A low value of χ^2 is an indicator of independence. The calculated value of χ^2 from eq. (1) was compared with the critical χ^2 value for the given degree of freedom and the probability distribution resulting in the lowest χ^2 value was selected as the best-fit distribution.

The expected weekly rainfall amounts at different exceedance probabilities for Durg, Dhamdha and Patan blocks were then determined using the best-fit distribution (Table 3 to Table 5).

Table: 2
Mean annual, seasonal and weekly rainfall availability at study Blocks

Period/SMW	Rainfall availability		
	Durg	Dhamdha	Patan
Annual	1067.9	908.7	1088.8
Seasonal (monsoon)	1045.0	844.0	1054.0
23	11.8	9.4	17.6
24	66.2	48.6	53.3
25	60.9	44.8	48.3
26	41.0	62.1	40.8
27	76.7	58.2	76.1
28	53.3	66.7	66.9
29	74.6	50.6	90.7
30	91.2	82.0	81.5
31	57.3	56.1	109.6
32	71.1	60.2	63.7
33	88.9	56.7	84.2
34	85.4	57.2	79.7
35	59.5	55.6	69.3
36	43.5	36.1	47.3
37	34.7	32.3	41.3
38	46.9	24.5	27.3
39	19.9	12.7	11.4
40	23.7	16.6	8.2
41	9.6	3.8	6.9
42	18.6	12.7	22.4
43	10.4	6.6	7.3

Probable Evapotranspiration Demand

Weekly potential or reference evapotranspiration (ET_o) values were estimated using 20 years (1994-2013) climatic data of Durg district by Modified Penman method using CROPWAT software. Probability analysis of weekly ET_o values was carried out by fitting Gamma distribution and the expected ET_o values at different probability levels were computed. The crop coefficient (K_c) approach was used for calculating the crop evapotranspiration (ET_c) of rice for the monsoon weeks. The expected weekly ET_o values at 50% probability level were used for estimating actual ET_c values for corresponding weeks as suggested by Sahu (2000). The reason for using ET_o values at 50% probability level was that Senapati *et al.* (1996) used ET_o at 20% probability level and found that if this ET_o value is used for computing actual ET_c, then ET_{rice} would be overestimated as compared to long term measured values by lysimeter and drum culture technique. However, ET_c corresponding to ET_o at 50% probability level was found very close to the measured values. Therefore,

$$ET_c = K_c \text{ x } Et_o \quad ...(2)$$

Table: 3
Expected rainfall at different probability levels during monsoon at Durg Block

SMW/Period	Distribution	Probability levels (%)					
		25	40	50	60	75	80
23	Exponential	16.3	10.8	8.1	6.0	3.4	2.6
24	Exponential	91.7	60.6	45.9	33.8	19.0	14.8
25	Exponential	84.4	55.8	42.2	31.1	17.5	13.6
26	Exponential	56.8	37.6	28.4	21.0	11.8	9.2
27	Exponential	106.3	70.3	53.2	39.2	22.1	17.1
28	Exponential	73.9	48.8	36.9	27.2	15.3	11.9
29	Normal	116.1	90.1	74.5	59.0	33.0	22.8
30	Normal	160.1	117.1	91.2	65.2	22.2	5.1
31	Normal	93.1	70.8	57.4	43.9	21.6	12.7
32	Normal	108.1	85.0	71.1	57.1	34.0	24.8
33	Normal	137.0	107.0	88.9	70.8	40.7	28.7
34	Normal	126.6	101.0	85.4	69.9	44.2	30.0
35	Normal	98.8	74.3	59.5	44.7	20.2	10.4
36	Normal	69.8	53.3	43.5	33.6	17.1	10.6
37	Exponential	48.1	31.8	24.1	17.7	10.0	7.7
38	Exponential	65.0	43.0	32.5	24.0	13.5	10.5
39	Exponential	27.5	18.2	13.8	10.1	5.7	4.4
40	Exponential	32.9	21.7	16.4	12.1	6.8	5.3
41	Exponential	13.3	8.8	6.7	4.9	2.8	2.1
42	Exponential	25.7	17.0	12.9	9.5	5.3	4.1
43	Exponential	14.4	9.5	7.2	5.3	3.0	2.3
Monsoon	Normal	1346.7	1158.1	1044.7	931.3	742.7	667.9

Table: 4
Expected rainfall at different probability levels during monsoon at Dhamda Block

SMW/Period	Distribution	Probability levels (%)					
		25	40	50	60	75	80
23	Exponential	67.4	44.5	37.7	24.8	14.0	10.9
24	Exponential	62.1	41.1	31.1	22.9	12.9	10.0
25	Exponential	86.1	56.9	43.1	31.7	18.9	13.9
26	Exponential	80.6	53.3	40.3	29.7	16.7	13.0
27	Exponential	92.5	61.6	46.2	34.1	19.2	14.9
28	Exponential	111.7	73.8	55.9	41.2	23.2	18.0
29	Normal	110.5	91.8	80.6	69.3	50.7	43.3
30	Normal	122.8	97.0	82.0	66.9	41.9	31.9
31	Normal	87.6	68.0	56.1	44.3	24.7	16.9
32	Normal	85.3	69.7	60.2	50.8	35.8	29.0
33	Normal	95.1	71.1	56.7	42.3	18.1	8.9
34	Normal	88.8	69.0	57.2	45.3	25.6	17.8
35	Normal	86.1	67.1	55.6	44.2	25.1	17.6
36	Normal	57.3	44.1	36.1	28.2	14.9	9.7
37	Exponential	34.0	22.5	17.0	12.9	7.1	4.5
38	Exponential	17.7	11.7	8.8	6.5	3.7	2.8
39	Exponential	23.0	15.2	11.5	8.5	4.8	3.7
40	Exponential	5.2	3.5	2.6	1.9	1.1	0.8
41	Exponential	17.6	11.7	8.8	6.5	3.7	2.8
42	Exponential	9.2	6.1	4.6	3.4	1.9	1.4
43	Exponential	8.7	5.7	4.3	3.2	1.8	1.4
Monsoon	Normal	1037.1	941.2	883.7	825.9	730.0	692.0

The values of ET_c for two consecutive weeks during monsoon period have been computed based on daily ET_o at 50% probability level computed from climatic parameters of Durg Block only. Since all the climatic parameters for Dhamdha and Patan blocks were not available; the estimated ET_o values of Durg Block were assumed to be applicable for Dhamdha and Patan blocks also as the climatic conditions of all the three Blocks are almost similar. The K_c values for the corresponding periods were adopted from previous research work carried out by Gul (2007). The computation of ET_c values that were common for all the three study Blocks have been worked out and are shown in Table 6.

Rainwater Surplus/Deficit

The surplus/deficit of rainfall for different weeks at 75%

Table: 5
Expected rainfall at different probability levels during monsoon at Patan Block

SMW/Period	Distribution	Probability levels (%)					
		25	40	50	60	75	80
23	Exponential	24.4	16.2	12.2	9.0	5.1	3.9
24	Exponential	74.0	49.0	37.0	27.3	15.4	11.9
25	Exponential	66.9	44.3	33.5	24.7	13.9	10.8
26	Exponential	56.6	37.5	28.4	20.9	11.8	9.1
27	Exponential	105.5	69.8	52.8	39.0	21.9	17.0
28	Exponential	92.8	61.4	46.5	34.2	19.3	15.0
29	Normal	135.2	107.4	90.7	74.0	46.2	35.2
30	Normal	119.3	95.7	81.6	67.4	43.8	34.4
31	Normal	173.5	133.6	109.6	85.6	45.7	29.9
32	Normal	100.3	77.4	63.7	50.0	27.1	17.0
33	Normal	146.7	107.4	84.2	31.0	22.5	7.1
34	Normal	124.7	96.6	79.7	62.8	34.8	23.6
35	Normal	127.2	91.1	69.4	47.7	11.6	6.9
36	Normal	66.7	54.6	47.3	40.1	28.0	23.2
37	Exponential	50.0	38.4	29.0	21.3	12.0	9.3
38	Exponential	37.8	25.0	18.9	13.9	7.8	6.1
39	Exponential	15.8	10.4	7.9	5.8	3.3	2.5
40	Exponential	11.3	7.5	5.7	4.2	2.3	1.8
41	Exponential	9.5	6.3	4.7	3.5	2.0	1.5
42	Exponential	31.1	20.5	15.5	11.5	6.5	5.0
43	Exponential	10.0	6.6	5.0	3.7	2.1	1.6
Monsoon	Normal	1227.7	1119.5	1054.3	989.3	881.1	838.2

Table: 6
ET_{rice} demand and rainfall at different growth stages at study Blocks

Growth stage (1)	SMW (2)	Daily ET_o at 50% Prob. (mm) (3)	K_c (4)	Daily Et_{rice} (mm) (5)	Total ET_{rice} demand (mm) (6) = (5)x14 days
Nursery	23+24	8.8	0.85	7.48	104.72
Seedling	25+26	5.5	0.89	4.895	68.53
Seedling	27+28	5.0	0.9	4.5	63
Vegetative	29+30	4.5	1.0	4.5	63
Vegetative	31+32	4.2	1.01	4.242	59.388
Vegetative	33+34	4.3	1.02	4.386	61.404
Reproductive	35+36	3.8	1.03	3.914	54.796
Reproductive	37+38	4.6	1.05	4.83	67.62
Reproductive	39+40	4.9	1.06	5.194	72.716
Maturity	41+42	4.7	1.0	4.7	65.8
Maturity	43	4.5	0.9	4.05	56.7
Total					737.674

and 80% probability of rainfall in comparison to ETc demands of rice crop for the corresponding weeks were worked out. The surplus/deficit values were worked out to know whether supplemental irrigation is needed in particular weeks of rice crop growth stages or not. The surplus/deficit rainwater availability is depicted in Fig. 2 to Fig. 4 for the study blocks.

3. RESULTS AND DISCUSSION

The prior knowledge of rainwater availability and ET demands of the crops is essential in effective planning of crop and water resources in order to obtain good crop yields. These are discussed herein.

Mean Rainwater Availability

The mean weekly, seasonal and annual rainfall received at Durg, Dhamdha and Patan blocks have been given in Table 2. It is evident from the Table that the mean annual rainfall of the three blocks was found to be 1067.9, 908.7 and 1088.8 mm with coefficient of variation of 0.41, 0.26

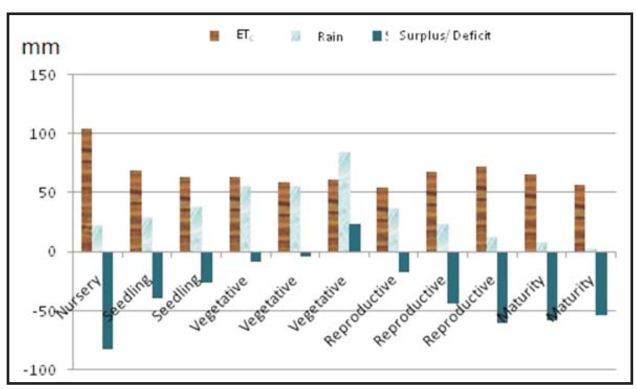

Fig. 2. Comparison of ET demand, rainwater availability and rain surplus/deficit at Durg Block

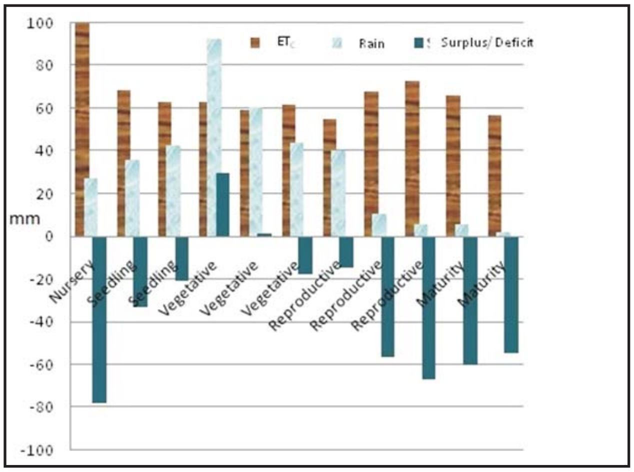

Fig. 3. Comparison of ET demand, rainwater availability and rain surplus/deficit at Dhamdha Block

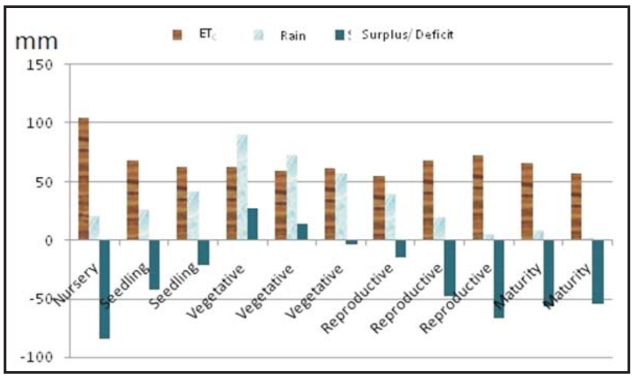

Fig. 4. Comparison of ET demand, rainwater availability and rain surplus/deficit at Patan Block

and 0.26 at Durg, Dhamdha and Patan blocks, respectively. The lower coefficient of variation was observed at Dhamdha and Patan blocks in comparison to Durg block. It indicates that variability in mean annual rainfall is less at Dhamdha and Patan blocks with more stability in the rainwater availability as compared to Durg block. About 98, 97 and 98% of annual rainfall were received at Durg, Dhamdha and Patan blocks, respectively during monsoon season and negligible amounts of rainfall in winter. Therefore, under rainfed conditions, only less moisture intensive crops like gram, moong, safflower *etc.* can be grown in comparatively heavy soils of the study areas.

The normal, deficient and excess rainfall years were worked out based on mean annual rainfall and standard deviation. The analysis of 20 years annual rainfall data revealed that 20, 11 and 22% of the years were found to be excess rainfall years at Durg, Dhamdha and Patan blocks, respectively whereas 55% at Durg, 66% at Dhamdha and 50% years at Patan blocks experienced rainfall deficit years and the rest 25, 23 and 28% years at these blocks were observed as normal rainfall years. This indicates that Dhamdha block is relatively more prone to yearly rainfall deficiency in comparison to Durg and Patan blocks.

Mean weekly rainfall data showed that the highest mean weekly rainfalls of about 91 and 82 mm were recorded at Durg and Dhamdha blocks, respectively in 30th SMW, whereas Patan block recorded highest mean weekly rainfall of 109.6 mm in 31st SMW. Both 30th and 31st SMWs fall during vegetative growth period of rice crop. It indicates that sufficient rainfall occurred during this period. During early reproductive period (3538 SMW) of rice crop, total availability of rainfall is about 184.6 mm against the ET requirement of 122.5 mm at Durg block. At Dhamdha block, total rainfall availability was recorded during 35 to 38 SMW to be 148.5 mm against the ET requirement of 122.5 mm, whereas at Patan block, the rainfall availability was recorded during the same period to be 185.2 mm against the ET demand of 122.5 mm. This shows that during early reproductive phase, which includes flowering stage also, the rainwater availability is quite high as compared to the ET demand of rice crop and the crop will not face drought condition during this period. The later period (39-40 SMW) of reproductive stage includes grain formation and milking phases. The rainwater availability during this period was observed to be much lesser (28.7 to 52.7 mm) as compared to ET demand of about 72.3 mm. This indicates that rainwater is in shortage to meet the ET demands during grain formation and milking stages and any water shortage during this period may adversely affect the quality and weight of the rice grain resulting in reduced yield. Therefore, supplemental irrigation is essential to meet out the water shortage at all the places, if full potential yield is to be realized. Thus, for attaining higher rice yield, rainwater harvesting is essential for providing supplemental irrigation to rice during terminal dry spell period.

Probable Rainwater Availability

The expected amounts of rainfall at different probability levels have been worked out and are given in Tables 3 to Table 5 for Durg, Dhamdha and Patan blocks, respectively. Results revealed that during early (23-28 SMW) and recession (37-43 SMW) periods of monsoon season, the exponential distribution is found good fit to available rainfall amounts at all the blocks. During active monsoon period (29-36 SMW) and monsoon season as a whole, the normal distribution fits well based on Chi-square test. It is also found that expected seasonal (monsoon) rainfall amount at 75% probability level is recorded to be 743, 730 and 881 mm at Durg, Dhamdha and Patan blocks, respectively. Whereas, at 50% probability level of potential evapotranspiration (ET_o), the ET_c demand of rice in whole crop duration is estimated to be 738 mm for medium duration variety. This indicates that if the whole crop duration is taken into consideration, the seasonal availability of rainwater seems to be sufficient for growing rice crop in all the three Blocks. Patan block recorded about 16-17% higher seasonal rainfall than Durg and Dhamdha blocks. This indicates that more water can be harvested at Patan block as compared to rest of the two blocks.

Though, expected seasonal (monsoon) rainwater availability at the three blocks appears to be sufficient for growing of rice crop; however, growth stage-wise distribution of probable rainwater availability is not found to be enough to meet ET demands at all growth stages. Rice growth stage-wise probable rainwater availability has been compared with corresponding ET demands in Fig. 2 to Fig. 4 for Durg, Dhamdha and Patan blocks, respectively. It is found that about 23.5 mm rainfall is received in surplus to ET demand of rice crop at vegetative stage (33 + 34 SMW) in Durg block; 29.6 mm during seedling stage (27 + 28 SMW) in Dhamdha block and about 40 mm during vegetative stage in Patan block. Beside the above stated periods, the expected rainfall availability during other crop growth stages, exhibits rainwater deficit as compared to corresponding crop ET demands in all the study blocks. The largest (6984 mm) rainwater deficiency is expected to occur at nursery stage. This indicates that raising a good and healthy rice nursery is not possible if dependent on rainwater only. Thus, supplemental irrigation will be needed during nursery stage. Similarly, reproductive stage is likely to experience considerable shortage of rainwater availability when compared with ET demand in all the three blocks. Reproductive phase is considered as the most critical rice growth stage and any shortage of water at this stage is very detrimental to crop yield. The rainwater shortage during crop maturity period is not much important but it is considered beneficial for timely maturity and harvest of rice crop. As a part of water resources planning, surplus rainwater periods (seedling and vegetative growth periods) at all the three Blocks can be utilized by harvesting excess rainwater in on-farm storage structures for recycling during reproductive stage in order to realize optimum rice crop yield.

4. CONCLUSIONS

The mean annual and seasonal rainfall at all the study blocks appears to be sufficient for rice crop but probability distribution of weekly rainfall is quite erratic. Nursery stage and later two weeks of reproductive stage are likely to suffer severely from drought situation at all the three study blocks. The excess rainwater during seedling and vegetative growth stages should be harvested in on-farm storage structures for providing supplemental irrigation to rice crop during reproductive stage in order to obtain good yield. The analysis of mean annual and seasonal rainfall also indicates that about 55 to 66% years experienced rainfall deficit years at all the three study blocks. This is also indicative of severity of drought conditions for rice crop in the whole Durg district and emphasize upon the essential necessity for rainwater harvesting at farm levels to mitigate the drought effect in rice crop.

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