GAU Res. J. 1992. 18 (1) : 1-6

Analysis of Rainfall Data and its Relation with Crop Management and Planning

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ABSTRACT

Twenty three years (1966-88) of daily rainfall data were analysed to determine 1, 2, 3, 4, 5 and 6 days maximum rainfall of different years recurrence interval. The probability analysis is done using Gumbel distribution. Results indicate that maximum six days rainfall of 1.01 year return period is 153.24 mm with nine days maximum dry spell during monsoon season. The rainfall values of weekly, seasonal and annual at different probability levels (1%-99%) were computed for crop planning. The rainfall of 62.56-148.08 mm in Rabi season with 2-10 years return periods can meet the demand partly to the rabi crops. The kharif crops can be successfully raised in this region under rainfed conditions. The weekly rainfall at 80 per cent chance is expected in 25th meteorological week, hence would be helpful in seed bed preparation and dry sowing of kharif crops in 24th meteorological week under rainfed condition.

(Received on 15th Febru, 1990)

INTRODUCTION

Rainfall is the single most main climatic parameter responsible for diversity in crop productivity under rainfed conditions. Vagaries of rainfall are well known. Rainfall is erratic and uncertain in time, space and quantum. Modern agriculture methods comprising of moisture conservation techniques, use of improved varieties, applying chemical fertilizers have considerably increased the input cost in rainfed farming. But in rainfed farming crop planning and its success is solely dependent upon amount and distribution, of rainfall. Rainfall distribution in Dhule region (M.S.) is most uneven and varies considerably from year to year. Hence, with the introduction of costly inputs in rainfed farming it has become imperative to use rainfall probabilities at different levels for crop planning.

For planning an irrigation water supply system, the irrigation water requirement during different months of the crop's growing period is a function of rainfall deficits in those months. Thus rainfall deficit information for different areas and periods can greatly help in determining the optimal water releases from a reservoir in accordance with demand.

Frequency analysis of rainfall data for different meteorological stations in the country has been done (Kundu, 1972; Sharma, 1986; Prakash and Rao, 1986). Sharma *et al.* (1979) reported that the weekly data of rainfall was found to be more useful for planning of cropping programme as well as water

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management practices than monthly, seasonal, or annual data. Ray *et al.* (1980) studied the prediction of weekly rainfall at different levels of probability, which provided valuable guide lines for crop planning especially under dryland situations. However, such rainfall analysis on specific area basis would give better prediction. With this in view, the probability and frequency analysis on the rainfall data has been carried out as given in this paper.

MATERIALS AND METHODS

Daily rainfall data collected from the meteorological observatory for a period of 23 years (1966-88) were used for analysis. The observatory is 253 m above mean sea level with 21.4° N and 74.46° E as latitude and longitude, respectively. The daily rainfall data was lumped to form weekly, monthly and yearly time series. Similarly the monthly rainfall data was gathered to obtain the different seasons.

The annual maximum one day, two days, three days, four days, five days and six days total rainfall data was analysed and frequency distribution computed for different return periods as an annual series. The return period values were obtained by using Weibull's formula. Gumbel distribution method was applied to compute the expected maximum theoretical rainfall amounts of different return periods for one day, two days, three days, four days, five das and six days. The values of maximum length of dry spells of different recurrence intervals in the monsoon season were calculated following this procedure. The expected total rainfall values of different return periods were also computed for the various seasons.

The weekly rainfall amounts corresponding to their probability levels from 22nd to 39th standard weeks (June to September) each year were computed. The average weekly rainfall values and maximum weekly rainfall amounts for each year were also calculated.

RESULTS AND DISCUSSION

The probable rainfall magnitudes and the corresponding recurrence intervals for one day, two days, three days, four days, five days and six days and lengths of dry spell in monsoon season were computed from the 23 years daily rainfall data and have been presented in Table 1. The theoretical maximum rainfall amounts against per cent chance are plotted in Fig. 1.

From Table 1, it was evident that maximum six days rainfall of 1.01 year return periods is 153.24 mm and the corresponding length of dry spell is nine days and this could

TABLE 1

Maximum daily rainfall (mm) and dry spells at different levels of probability.

Maximum rainfall	*Return period, year*							
	1.01	*1.05*	*1.25*	*2.00*	*5*	*10*	*20*	*100*
One day	22.20	35.02	53.13	78.02	110.84	133.26	154.22	202.12
Two days	58.84	76.11	100.51	134.05	178.26	208.47	236.71	301.47
Three days	85.71	107.05	137.19	178.63	233.24	270.56	305.44	385.17
Four days	113.36	137.09	170.59	216.66	277.39	318.88	357.66	446.30
Five days	135.87	162.17	199.29	250.34	317.62	363.60	406.56	504.78
Six days	153.24	182.42	223.61	260.24	354.90	405.91	453.38	562.56
Max-dry spell in monsoon season (days)	9	10	12	14	17	19	21	25

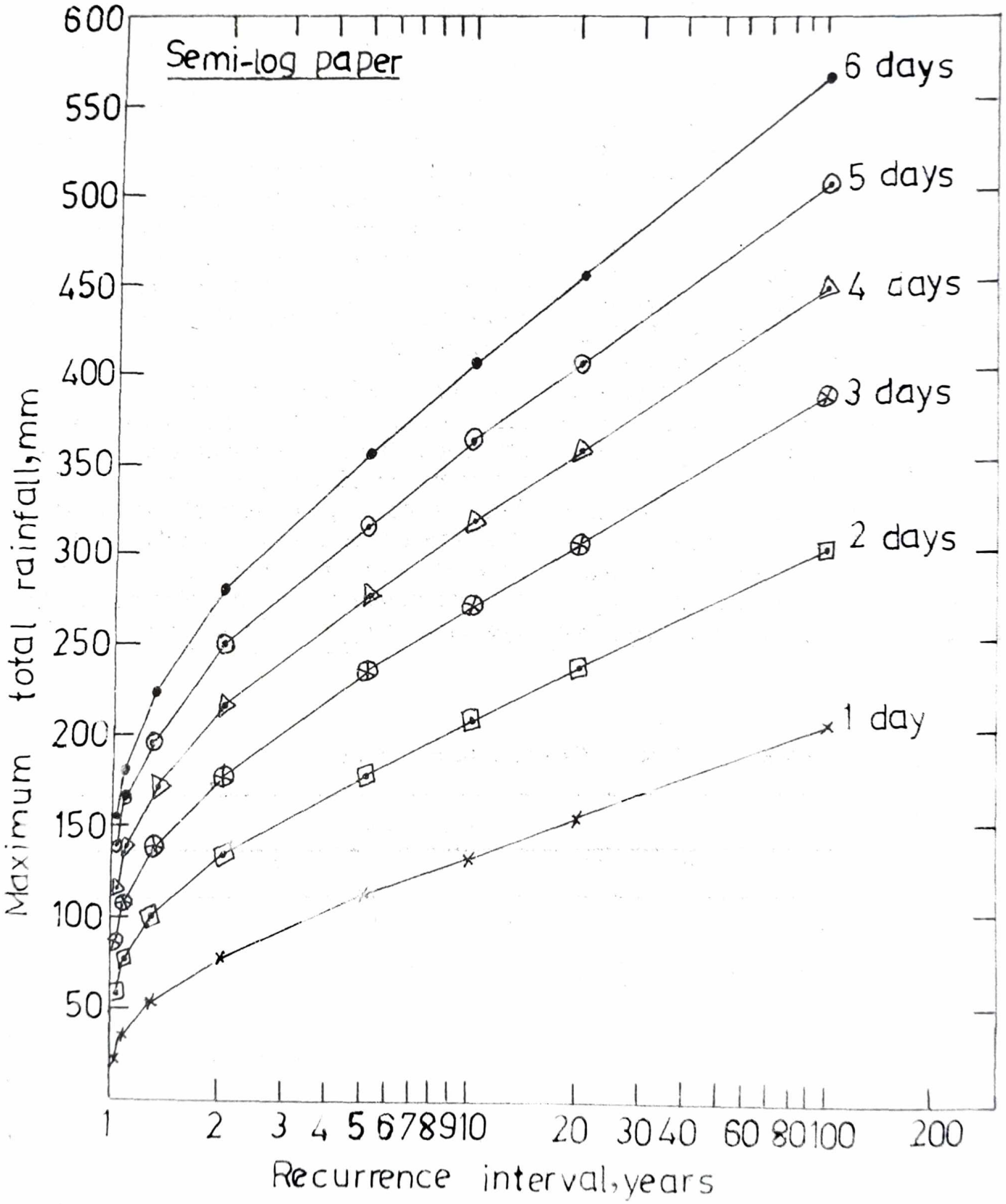


Fig.1 : Frequency analysis of maximum total rainfall.

be taken as the design storm. In five years return periods, the probable maximum rainfall values were 110.84, 178.26, 233.24, 277.39, 317.62 and 354.90 mm with one day, two days, three days, four days, five days and six days, respectively, for maximum dry spell of 17 days during monsoon season. There would be crop failures/reduction in yields, with a continuous dry spell of more than 12 days in between two rainy days. If this dry spell coincides with the critical stage of a crop, considerable damage may be caused to crop yields.

Seasonal and annaul rainfall values expected at different probability levels showed that the range of 2-10 years return periods is important for agricultural purposes (Table-2). The rainfall amount predicted at 80 per cent probability can be taken as minimum assured value and for crop planning that amount of rainfall should be available during the particular period. At 50 per cent probability, the crop planners may grow crops taking the risk, where there is another 50 per cent chance of crop failure. Similarly for rainfall expected at 10 per cent probability, the risk of crop planning is excessive where there is chance of failure in 9 out of 10 events. Considering 80 per cent probability, the expected rainfall amounts were 383.23, 24.01 and 3.06 mm with kharif, rabi and summer season, respectively. Appreciable rainfall expected in kharif season would be sufficient to sustain kharif crops and varieties having low water requirement. But, in rabi and summer seasons, low amount of rainfall received would result in failure of crop.

In the range of 2-10 years return periods, it can be seen that for the rabi season (October to January), the rainfall of 62.56 to 148.08 mm can meet the demand partly of rabi crops. Further the probable rainfall values of were 728.17 and 815.32 mm, respectively with kharif season and annual for 10 years return periods.

The weekly rainfall amounts corresponding to their probabilities were calculated. The weekly rainfall amounts at 95 per cent and 99 per cent were nil, hence these values have not been shown in table. Computation of weekly rainfall has been shown in Table 3. Considering the rainfall at 80 per cent probability, amounts of rainfall will be expected only from the 25th to 37th

TABLE 2

Seasonal expected rainfall (mm) for different return periods.

Season	*Return period, year*							
	1.01	*1.05*	*1.25*	*2*	*5*	*10*	*20*	*100*
Kharif (June to Sept.)	250.10	305.30	383.23	490.39	631.65	728.17	818.36	1024.54
Rabi (Oct. to Jan.)	0	0	24.01	62.56	113.36	148.08	180.52	254.69
Summer (Feb. to May)	0	0	3.06	14.71	30.06	40.55	50.36	72.77
Annual	342.40	397.00	474.10	580.10	719.83	815.32	904.53	1108.51

TABLE 3

Weekly expected rainfall (mm) of different return periods.

Month	Meteorological week	Return period, year						Maximum rainfall	Average rainfall
		1.25	2	5	10	20	100		
June	22	0	8.00	26.42	39.00	50.76	77.65	68.60	11.39
	23	0	15.45	53.36	79.26	103.47	158.80	166.80	22.43
	24	0	23.73	57.59	80.69	102.29	151.68	151.00	29.96
	25	3.24	24.85	53.33	72.80	90.98	132.56	107.00	30.09
	26	8.24	41.83	86.11	116.38	144.65	209.29	186.60	49.98
July	27	0.35	20.64	47.38	65.66	82.73	121.77	108.00	25.56
	28	7.89	27.97	54.43	72.52	89.42	127.61	98.80	32.84
	29	0.91	25.13	57.06	78.88	99.27	145.88	136.00	31.01
	30	4.74	31.55	66.89	91.04	113.60	165.19	154.80	38.05
	31	0	39.78	104.61	148.91	190.29	284.38	349.50	51.71
August	32	1.74	22.70	50.33	69.22	86.86	127.19	122.20	27.79
	33	3.28	27.22	58.78	80.34	100.49	146.55	122.70	33.03
	34	0	17.70	42.92	60.15	76.26	113.07	113.20	22.34
	35	5.55	22.60	45.07	60.43	74.78	107.58	85.20	26.74
Septe-	36	0	21.01	77.66	116.38	152.55	235.25	285.20	31.43
mber	37	1.64	28.07	33.06	46.13	57.76	84.36	84.10	18.82
	38	0	19.38	46.41	64.89	82.15	121.60	133.00	24.36
	39	0	16.72	48.63	70.44	90.81	137.39	129.20	22.59

meteorological weeks and a maximum rainfall of 8.24 mm was available in the 26th meteorological week but there was no rainfall in the 31st, 34th and 36th meteorological weeks. The dryland farming crops like maize, bajra, ragi, pulses and other fodder crops can be sown in 24th meteorological week as rainfall is expected in 25th meteorological week and in the subsequent meteorological weeks.

In a similar way crop planning may be done at 50 per cent chance rainfall also but it will be the maximum limit for taking any risk for planning the cropping programme. Weekly rainfall analysis may be useful for planning of irrigation schemes for the area.

ACKNOWLEDGEMENT

Authors are thankful to the Professor of Agronomy, College of Agriculture, Dhule (M.S.) for providing daily rainfall data.

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